NATIONAL PLANNING COMMITTEE SERIES

Rural Marketing and Finance

River Training and Irrigation

Soil Conservation and Afforestation

Land Policy, Agricultural Labour and Insurance

Animal Husbandry and Dairying, Horticulture and Fisheries

Crops—Planning and Production

Rural and Cottage Industries

Power and Fuel

Chemical Industries

Mining and Metallurgical Industries

Manufacturing Industries

Industries connected with Scientific Instruments and Engineering Industries

Labour

Population

Trade—(Internal and Foreign)

Public and Industrial Finance

Currency, Exchange and Banking

Insurance (Individual and Social)

Transport (Road, Rail, Air and Water)

Communications (Posts, Telegraphs, Telephones and Radio)

National Housing

Public Health

Education—General and Technical

Woman's Role in Planned Economy

NATIONAL PLANNING, PRINCIPLES & ADMINISTRATION

K. T. Shah.

NATIONAL PLANNING COMMITTEE SERIES

(Reports of the Sub-Committee)

ENGINEERING INDUSTRIES AND SCIENTIFIC INSTRUMENTS INDUSTRIES

ENGINEERING INDUSTRIES

Chairman

Shri P. N. Mathur

Secretary

The Hon. Mr. M. N. Dalal

INDUSTRIES CONNECTED WITH SCIENTIFIC INSTRUMENTS

Chairman

Dr. P. N. Ghosh

Secretary

Principal G. P. Paranjpe

Edited by

K. T. Shah

Honorary General Secretary

NATIONAL PLANNING COMMITTEE

VORA & CO., PUBLISHERS LTD.

3, ROUND BUILDING, KALBADEVI ROAD, BOMBAY 2.

First Published, March, 1948

Price Rs. 6/- only

Printed by Dhirubhai Dalal at the Associated Advertisers & Printers Lt
505, Arthur Road, Tardeo, Bombay 7, and Published by M. K. Vora
for Vora & Co. Publishers Ltd., 3, Round Building, Bombay 2.

To

All Those

MEMBERS OF THE NATIONAL PLANNING COMMITTEE

and of

Its Various Sub-Committees

A TRIBUTE OF APPRECIATION

प्रारब्धमुत्तमजना न परित्यजन्ति

PERSONNEL OF THE SUB-COMMITTEE OF ENGINEERING INDUSTRIES

Chairman

Mr. P. N. Mathur

Secretary

The Hon. Mr. M. N. Dalal

Members

Mr. Maurice Frydman

Prof. A. K. Shaha

Rao Bahadur G. N. Nagaratnam Iyer

Shri B. Vishwanath

Dr. A. Pandya

Shri S. L. Kirolskar

Shri Dhanpal Chandra

Shri Ratanchand Hirachand

Prof. R. S. Jain

Dr. J. N. Basu

Shri N. N. Rakshit

Shri M. Venkatesh, (Mysore Govt. Rep.)

Shri V. R. Kalappa,
(Delegate of the Labour Sub-Com.)

PREFACE

The National Planning Committee, appointed in 1938, began its work early in 1939. After defining the nature of a National Plan, and determining the nature and scope of the work entrusted to them, the Committee issued an elaborate and comprehensive Questionnaire which was subsequently supplemented by specific details. Twenty-nine Sub-Committees, formed into eight groups, were set up with special terms of reference to deal with all parts and aspects of the national life and work in accordance with a predetermined Plan.

After some unavoidable delay in getting replies to the Questionnaire, the Sub-Committees began their work, and submitted Reports,—some of them Final, some Interim,—which were considered at the Plenary Sessions of the Parent Committee in 1940. Towards the end of that year the Chairman, Pandit Jawaharlal Nehru, was arrested and sentenced to a long term of imprisonment, during which the work of the Committee had necessarily to be suspended.

On his release a year later, hope revived for an intensive resumption of the Committee's work. But the outbreak of war with Japan, the threat to India's own safety, and the hectic march of political events, rendered it impossible to devote any attention to such work at that time. It, therefore, inevitably went into cold storage once again; and remained for the duration of the war.

When at last the War seemed nearing its end, Pandit Jawaharlal Nehru with other leaders was released. The moment seemed again opportune to resume the work of

the Planning Committee. Meetings of that Body were held in September and November 1945, when certain more urgent questions, already included in the programme of the National Planning Committee, were given a special precedence. A Priority Committee was appointed to report upon them. Changes and developments occurring during the War had also to be taken into account; and another Committee was appointed to review the general instructions, given six years earlier to the Sub-Committees. Revised instructions were issued to them following the Report of this Sub-Committee; and the Chairmen and Secretaries of the several Sub-Committees were once again requested to revise and bring up to date such of the Reports as had already been submitted—either as final or interim—while those that had not submitted any reports at all were asked to do so at an early date.

As a result, many of the Sub-Committees which had not reported, or had made only an Interim Report, put in their Reports, or finalised them. The Parent Committee has had no chance to review them, and pass resolutions on the same. But the documents are, by themselves, of sufficient value, prepared as they are by experts in each case, to be included in this Series.

The following Table shows the condition of the Sub-Committees' work, and the stage to which the Planning Committee had reached in connection with them.

Serial No.	Name of the Sub-Committee.	Final Report		Interim Report		No Reports
		N.P.C. Resolutions	Not considered by N.P.C.	N. P. C. Resolution	Not considered by the N.P.C.	
Group I.	**Agriculture & other Sources of Primary Production**	Handbook Pp.		Handbook Pp.		
1.	Rural Marketing and Finance	97-99				
2.	River Training and Irrigation Part I	83-85				
	,, ,, ,, Part II	113-115				
3.	Soil Conservation and Afforestation	115-119				
4.	Land Policy and Agriculture			139-141		
5.	Animal Husbandry and Dairying	87-89				
6.	Crop Planning and Production				do	do.
7.	Horticulture	102-103				
8.	Fisheries					
Group II	**Industries or Secondary Sources of Production**					
1.	Rural and Cottage Industries					
2.	Power and Fuel		do.			
3.	Chemicals					do.
4.	Mining and Metallurgy			77-79		
5.	Engineering Industries	75-77		130-133		
6.	Manufacturing Industries		do.			
7.	Industries connected with Scientific Instruments		do.			
Group III	**Human Factor**					
1.	Labour	89-92				
2.	Population	85-87				
Group IV	**Exchange and Finance**					
1.	Trade					
2.	Public Finance					
3.	Currency and Banking			122-126		
4.	Insurance			93-95		
Group V	**Public Utilities**			95-97		
1.	Transport					
2.	Communications	126-129		120-122		
Group VI	**Social Services—Health and Housing**					
1.	National Housing					
Group VII	**Education**					
1.	General Education			133-139		
2.	Technical Education				do.	
Group VIII	**Woman's Role in Planned Economy**					

To sum up, fourteen Sub-Committees had made final reports, of which ten have been considered, and Resolutions taken upon them, by the National Planning Committee. Twelve more have presented Interim Reports, of which nine have been considered by the Planning Committee, with Resolutions thereon, while three Sub-Committees have not yet presented any report on the reference made to them.

The idea that all this material, gathered together with the help of some of the best brains in India in the several departments of our national life, should be printed and published was before the Committee from the start. But the interruption caused by the war prevented its realisation. It was once again mooted in 1941; but the moment was not deemed ripe then for such action, partly because the leading spirits in almost every one of the Sub-Committees were unable to devote time and labour to bring their Reports up-to-date; and partly also because war-time restrictions or shortages had made scarcer than ever before the statistics and other facts, which particular sub-committees would need, to bring their work up-to-date. The war-time needs of Government had attracted several of them to work on Government Bodies, Panels, or Committees. For all these reasons it was deemed undesirable that material of this character—valuable as it must be—should be put out in an incomplete, inchoate, obsolete form, which may reflect unfavourably upon Indian capacity for such tasks.

The last four years of the War were thus a period of suspended animation for the National Planning Committee. Even after the end of the war, it has not been feasible, for obvious reasons, for the Planning Committee to resume its work and finalise decisions. Continuous sessions of that body are indispensable for considering and taking decisions on the Sub-Committee reports presented since 1940, and putting all the material into shape, ready for publication, not to mention making its own Report: but the political situation in the country made it impossible. Other conditions, however, are somewhat more favourable than in 1938-39, when the Central Government of the country were all but openly hostile to such attempts. Lest, however, the momentary difficulties make for needless further delay, it was thought advisable by the Chairman and the undersigned that no more time should be lost in putting this material before the Public. Following this advice, it is now proposed to bring out a complete Series of the National Planning Committee's Sub-Committee Reports, which will

serve as appendices to the Parent Committee's own Report. The Plan of the proposed enterprise is briefly summarised below.

Every Sub-Committee's Report, which is in a final form and on which the National Planning Committee has itself taken resolutions, will be edited and published, with an Introduction assigning their due importance to the suggestions and recommendations contained in that particular report, its proper place in the over-all National Plan; and following it up, wherever necessary, by a kind of Epilogue, summarising the developments that have taken place during the seven years, during which the work of the Planning Committee had been in suspension.

Those Reports, again, which, though in a final form, have not yet been considered, and no resolutions taken thereon, by the Planning Committee, will also be included in the Series in the form in which they were submitted, with such Introduction and Epilogue to each as may be deemed appropriate. And the same treatment will be applied to Reports which are 'Ad Interim', whether or not the Parent Committee has expressed any opinion on the same. They will be finalised, wherever possible, in the office, with such aid as the Chairman or Secretary of the Sub-Committee may be good enough to render. Sub-Committees finally, which have not submitted any Report at all, —they are very few,—will also find their work similarly dealt with. The essence, in fine, of the scheme is that no avoidable delay will now be suffered to keep the National Planning Committee's work from the public.

Both the Introduction and the Epilogue will be supplied by the undersigned, who would naturally be grateful for such help as he may receive from the personnel of each Sub-Committee concerned. The purpose of these additions is, as already stated, to assign its true place to each such work in the over-all Plan; and to bring up the material in each Report to date, wherever possible.

Not every Sub-Committee's Report is sufficiently large to make, more or less, a volume by itself, of uniform size, for this Series. In such cases two or more Reports will be combined, so as to maintain uniformity of size, get-up, and presentation of the material. The various Reports, it may be added, would not be taken in the order of the classification or grouping originally given by the Planning Commit-

tee; nor even of what may be called the intrinsic importance of each subject.

In view of the varying stages at which the several Reports are, for reasons of convenience, it has been thought advisable to take up for printing first those which are final, and on which the Planning Committee has pronounced some resolutions. Printing arrangements have been made with more than one Press, so that two or three Reports may be taken simultaneously and published as soon as possible so that the entire Series may be completed in the course of the year.

Two other Sub-Committees, not included in the list of Sub-Committees given above, were assigned special tasks of (1) preparing the basic ideas of National Planning; and (2) outlining the administrative machinery deemed appropriate for carrying out the Plan. These were unable to function for reasons already explained. The present writer has, however, in his personal capacity, and entirely on his own responsibility, published the "Principles of Planning" which attempt to outline the fundamental aims and ideals of a National Plan. This remains to be considered by the Planning Committee. Similarly, he has also attempted to sketch an administrative machinery and arrangements necessary to give effect to the Plan, when at last it is formulated, and put into execution. Notwithstanding that these two are outside the Scheme outlined in this Preface, they are mentioned to round up the general picture of the arrangements made for publication of the entire work up-to-date of the National Planning Committee and its several Sub-Committees.

The several volumes of Sub-Committee Reports, when published, will be treated as so many appendices to the Report of the parent body, the National Planning Committee. It is impossible to say when that Committee, as a whole, will be able to hold continuous sessions, review and resolve upon Sub-Committee Reports which have not yet been considered, and lay down their basic ideas and governing principles for an all over Plan, applicable to the country, including all the facts of its life, and all items making up the welfare of its people.

The disturbed conditions all over the country, and the Labour unrest that has followed the end of the War has caused unavoidable delays in printing and publishing the

several volumes in the Series, which, it is hoped, will be excused.

In the end, a word of acknowledgment is necessary to put on record the aid received by the Editor in the preparation and publication of this Series. All those who are associated in the task,—members of the Parent Committee, or as Chairmen, Secretaries or Members of the various Sub-Committees,—have laboured wholly, honorarily, and consistently striven to give the best that lay in them for the service of the country. Almost all Provincial Governments and some States,—the latter twice in some cases,—have made contributions towards the expenses of this office, which have been acknowledged and accounted for in the Handbooks of the Planning Committee, published earlier. Suitable appreciation of these will be expressed when the Parent Committee makes its own Report. At almost the end of its task, the expenditure needed to edit, compile, and otherwise prepare for the Press, the several Reports, has been financed by a Loan by Messrs. Tata Sons Ltd., which, even when repaid, will not diminish the value of the timely aid, nor the sense of gratitude felt by the undersigned.

Bombay, 1st July 1947. K. T. Shah.

Note:—In the Scheme of this Series, originally given, more than one Report was intended to be included in one volume in some cases. The combinations indicated in the circular, of the 20th of June 1947, had had to be modified as the printing of several Reports proceeded.

When about half the volumes were printed, it was found that that scheme would not give a fairly uniform series. The new arrangement is given on the page facing the title page. Some changes have had to be made in that list e.g., the separation of the two Reports on Public Health and National Housing, intended to be in one volume, are now in separate volumes.

Conversely, only the two Reports on Animal Husbandry and Dairying and on Fisheries were intended to be combined. As now decided, the Report on Horticulture is also included in the same Volume.

Again, the original combination of the Report on Mining and Metallurgy with that on Engineering Industries has been modified. The latter now combined with the Report on Industries Connected with Scientific Instruments, which was originally meant to be a separate volume, while the former is to be by itself.

31st January, 1948. K. T. S.

CONTENTS

INTRODUCTION

This Sub-Committee was appointed to consider the following Terms of Reference:—

(a) to make a general survey of the present annual imports of machines, machine tools and instruments and prime movers etc.
(b) to examine the present state of production in India of above;
(c) to find out what will be the country's requirements, of machines, machine tools and prime movers, including automobiles, locomotives, wagons, ships, aircraft and their parts and accessories during the next ten years with due regard to the relative urgency in different cases;
(d) to recommend measures which should be taken to manufacture in the country India's requirements under (c) above.

Importance of these Industries in Planned Economy

This group of heavy industries constitutes the foundation stone of planned economy, which is aimed at intensive industrialisation of the country. Modern industries of all kinds—whether manufacturing, mining, forest produce or other subsidiaries,—are becoming progressively mechanised, producing a standard article on mass scale for an unknown market. Such machinery, plant and equipment have become more and more complex replacing human labour in almost every operation involved in the production of new wealth in agriculture or industry. The group of industries here considered concern the production of these basic aids to modern industries; and as such it is regarded as an indispensable pre-requisite of planned economy. It includes not only the making of machines of all kinds and for all industries, but also mechanised transport facilities, necessary for the proper development of all other industries as well.

Lop-sided Industrialisation for lack of this group

India has had, in the last hundred years or so, very bitter experience of several new industries being started, including certain forms of transport, in the country, which

produced only consumer goods, needed by the foreign element that had got into power in the country, or the defence requirements of the country. There was no thought, however, of the basic industries for essential machinery and equipment being established in the country. The result was that for every nut or bolt, every sheet or plate, India had to depend on foreign sources of supply for the equipment of her railways, for her ports, for her many factories and workshops. The moment a world war or any other disturbance came in the way, these supplies were either cut off; or were raised in price to such an extent as to be almost prohibitive. Even in less exacting circumstances of normal peace-time, the development of International Trusts and Combines in essential industries, like the Iron and Steel Industry, or Chemical Products, made the country exposed to the tender mercies of these foreign exploiters. Such attempts as were made in the country for starting its own industries in this behalf were frustrated, because of the much larger resources, more advanced technique and other advantages of these foreign competitors. In the home market itself the Indian aspirant to building up locally such industries was unprotected against the ruthless and incessant competition of foreign producers. And this apart from the unconscious sympathy, if not direct co-operation of the rulers of the country with those foreign producers facilitating unloading their wares upon the undefended Indian Market, thus preventing the rise of an essential or key industry within the country.

Heavy Industry and National Defence

It is not merely the needs of modern industrialisation that necessitate the immediate establishment and rapid development of such Heavy or Engineering Industries within the country on a large scale. The demands of our national security also require that such industries be set up at as early a date and be advanced as rapidly as possible. Modern war is won more and more with machines. They enter every branch of the Armed Forces in operating whether on land, sea, or air. We have not even the rudiments of an automobile industry; we have hardly begun building even ships of the merchant navy, let alone the larger naval craft of all kinds. And we are almost innocent of aircraft industry. And we can now no longer leave it to Britain to furnish us with these requirements of our national defence. India herself may be a peace-loving country; but that would not secure her frontiers against aggressive in-

tentions or conflicting interests of more imperialist neighbours. Particularly would that be so if it was known that she was helpless in the absence of her own armaments industry, and all the industries that feed the Armaments Industry; and also that she was dependent upon foreign supplies for the essential requirements of even a defensive war. The last World War has removed, at least for the time being, the danger of Asian aggressors like Japan. The latest developments in the field of internal politics have also removed the domination of Britain, which had in the past frequently dragged us into wars not of our seeking, much less in our interests, but simply due to the imperialistic ambitions of Britain.

Heavy Engineering Industry needed also for Agriculture

For reasons, therefore, of both peace and war, India must have these Engineering or Heavy Industries which are the **sine qua non** of all planned industrialisation. Even agriculture, if it is to be worked on modern lines on an intensive scale would need machinery of an ever-growing and complicated type. That machinery has yet to be made in this country. And the same holds good of other primary needs by way of mechanical equipment for railways and all the accessories of that service, which have been established for more than 90 years. The few establishments that have sprung up of late in this field are still struggling for their very existence. There is as yet no carefully thought out national policy for their being fostered, encouraged or developed, so as to become an essential part and integral feature of the national scheme of planned development. What is needed, therefore, is an intensive programme of establishing and developing these industries, up to a predetermined stage, and within a given period.

Prerequisites for founding this Industry

The essential prerequisites for the successful establishment of these industries are by no means lacking in this country. We have plenty of raw materials, in the shape of metallic ore found in many parts of the country. We have, of course, no scarcity of labour. There is, no doubt, a relative scarcity of power, though that deficiency is apt to be exaggerated by those who would not like to go in for intensive industrialisation. India has a considerable quantity of coal, even if she is not too well endowed in respect of petrol. But the deficiency in the quality and quantity of coal can be more than made good by developing hydro-

electric power, for which our rivers and mountains are admirably adapted. As explained in another Sub-Committee's Report,—that on Power and Fuel,—hardly 2% of the available hydro-electric resources of the country have been tapped. Perhaps all are not even known so far. Power from this source can be developed side by side with steam power derived from coal or electricity already available within the country. When the point is made, therefore, of the deficiency of the country in such an essential pre-requisite, what is really meant is comparative shortage, not absolute lack of the commodity concerned.

Location and Concentration of such Industries

In considering, however, the location and development of the heavy industries, two problems, already hinted at above, would have to be immediately confronted and solved. By its very nature such industry must be concentrated, if all the economies of large-scale production are to be realised. They must, likewise, be located in places where an abundant supply of not only raw material, but the necessary power and fuel is also assured.

On the other hand, there is the consideration of liability to destruction at one blow if such industries are all concentrated in the event of warfare breaking out in which India is involved. Though India is a large country, under modern conditions of active hostilities, and given the possibility of bombing from air, no part, even in a large country like this, can be safe from invasion and attack by an aggressor. As these are "key" industries, being the very foundation stone of the industrial growth of the country, their destruction would be the first aim of the enemy; and if destroyed, their loss would cause a vital injury which it would take years to repair. It would, accordingly, be advisable to diffuse or spread out these industries, wherever the raw material is available in the requisite quantities, where labour is plentiful, transport easy and market assured, so that the country is not dependent upon one region only having all these industries. It happens at the present time that the bulk, if not the entire, Iron and Steel Industry in this country is located near the Jharia Coal Fields in Bihar. This location has had to be selected because of the nearness of iron ore to coal in the same region requiring the minimum of haulage of heavy raw materials to the power source or vice versa. With the development of the hydro-electric power,—which is possible to develop in several parts of the country, wherever

large perennial rivers flowing through uneven terrain are to be found,—electric energy is far more efficient than either coal or steam power, or petrol. These are largely concentrated in one area of the country. It must also be added that the metallic ore resources of this country are not yet fully known or exploited. Much less have they been explored to the optimum degree that a properly made plan would demand. Such alternatives as Aluminium to Iron and Steel, that has held the field for a century or more as the basic industry for any programme of industrialisation, are not yet considered on any large scale. Under these circumstances the National Planner must consider seriously the problem of location and development of these industries on as wide a scale as possible. The primary considerations in that programme are:—(a) raw materials and (b) power.

No doubt we are not planning for war, as this country has no militarist ambitions of the type that Japan or Germany or even Russia may be said to entertain. But the possibility of war cannot yet be ruled out from the civilised world of to-day, notwithstanding the establishment of the United Nations Organisation. The country that refuses to be prepared for such an eventuality as a War, however hateful it may be, runs the utmost risk of losing its national independence and sovereignty.

Lack of Technical Skill

The second problem which also will have to be dealt with by the National Planner relates to the provision of adequate numbers of skilled labour and technical experience. Such large-scale industries as have developed in this field, have, it is true, turned out a measure of such skilled workmen that may well be regarded as a starting point for the further development in the same direction. On the other hand, modern science and the facilities of publicity of all the advances that science makes are also developing rapidly, so that the old bugbear of "trade secrets" no longer hinders the economic development of a country for lack of adequate aid from advances in material science. True, there are devices like patents, which can be used to restrict the utilisation of these advances, but they can either be bought on a royalty basis, or outright; or in unscrupulous and desperate hands they may even be stolen. This handicap, therefore, need not forbid the establishment of industry of this essential character.

Restrictive trade practices, again, of International Trade Combines, seeking a world monopoly of such key industries, cause a more formidable obstacle. But that, also, is possible to get round by negotiations, or by firm action on the part of the National Government that would effectively safeguard the indigenous interests against such practices. One of the items of the International Trade Charter, sponsored by the United Nations, relates to this very item; and wants to pledge all signatory countries to discourage such practices as much as in them may lie. India is a member of the United Nations, and is likely to sign the International Trade Charter including the Chapter on restrictive trade practices. But even if she is not able to guard effectively against these practices; or even assuming that the ingenuity of the competitor would defeat the provisions of law, the independent national sympathetic Government of free India may be credited with sufficient strength and sagacity to take over these industries in its own hand, and conduct them as collective State Enterprise. They can then be safeguarded, encouraged and developed in every way that the State as a whole may command.

The same arrangement would facilitate the supply of Technical Experience and skilled labour in case our own resources in that behalf are found not adequate for the rapidly developing Engineering Industries of the country. Government can obtain foreign technicians, as Russia has amply shown, on such terms as would attract these technicians for the stipulated period, and at the same time ensure that the advent of these technicians will not lead to a permanent mortgage of the country's primary interests to foreign capitalists. There is this essential difference between the importation of "skilled foreign technician" and of "foreign capital" for the development of our industries, which should not be overlooked; viz. that while "foreign technicans" are **ex hypothesi** only temporarily brought into this country on a definite contract for a specified job, and pledged at the same time to train up the indigenous labour to the required pitch, so that their place may be taken, when the contract expires, by local skilled labour, "Foreign Capital", once permitted to be invested in such key industrial position, becomes rooted in the land, and develops vested interests not always in harmony with the long-range interests of the country importing or harbouring such foreign capital. India has had, in the recent past, bitter experience of the iniquitous influence such capital exerts on the national policy, fiscal, financial or economic. For

reasons of national security in times of War; as well as for conserving all the natural resources of the country in indigenous hands, it would even be advisable to forbid categorically any foreign capital being invested in our agriculture, mines and forests; power and fuel enterprise; defence industries and other such key production. At a pinch one might even go so far as to say that rather than develop these natural resources, by the help of alien capital, it might be preferable to postpone their development until such time as we have enough capital and other resources of our own. Such a contingency need not happen at all; but if it does, we must be prepared to face it at any time. And even in non-key industries, if foreign capital is permitted at all, it must be on terms which would amply safeguard the long-term interests of the country. Though the International Trade Charter, to which reference has already been made, seems to encourage movement of capital from country to country, as a matter of freedom of trade and movement of goods, a country comparatively backward like India in matters industrial, cannot afford to admit such foreign capital freely and without conditions, if only because of the need to develop intensively her own industries and effectively to safeguard her own interests.

Having solved these two primary considerations in the establishment and growth of these industries, a word may also be said in regard to the agency which should develop these industries, admitting these are key industries of vital national importance both in peace and war. No risk should be run, therefore, of such industries being operated at any time not only against the fundamental interests of national security but what is still more important is that they should not be left to operate so as conceivably to defeat the programme of planned development such as has been envisaged and advocated throughout this Series.

From every point of view, therefore, i.e.,

(1) for an adequate development to the optimum degree of these key industries,

(2) to reconcile regional interests within the country itself,

(3) to readjust power and raw materials and other conditions for the foundation of these industries, as well as

(4) to guard effectively against foreign competition, and

(5) to ensure the security of the country in the event of war,

it seems the only course would be to develop these industries directly as a collective State enterprise. But if for any reason the country is not deemed ready at the moment for collective State enterprise in this field, (the argument is fallacious and is advanced obviously by interested parties for their own ends), the development of these industries cannot be left to absolutely free private profit-seeker uncontrolled in any way by the State. Most of the industries which are listed under this general category are practically new in this country. They would be established for the first time, as, for instance, the production of automobiles, railway locomotives, power plants and machinery of all kinds required for peace as well as war, other transport vehicles, communication instruments, and scientific apparatus, which would all need active aid from the State and effective protection against foreign competition if they are to hold their ground at all. Such aid or protection will come out of the public pocket in whatever form they are given, whether protective fiscal duties or cash subsidies. It is but just, therefore, that if the country collectively pays for the initial deficiencies, handicaps, obstacles in the path of full development of these industries, the country should also be entitled to reap the fullest possible benefits therefrom in peace or war.

It may be added that the basic policy of the Indian National Congress, declared in the famous Resolution passed at the Karachi Sessions in 1931, frankly admits that the **"key industries" should be owned and managed by the State.** True, the State then was under foreign domination up to 15th August 1947 and as such might not be entrusted with such vital matters. But now that we are free and an Independent Sovereign State of the Indian people has come into being there is no reason to apprehend any partiality to non-Indian interests; nor any encouragement of anti-Indian sentiment which in the past was largely apprehended and often justified; which made us distrustful of Government measures even when they seemed to be in our interests and which consequently retarded the economic development of the country to its legitimate proportions.

If, however, even the national Government of India is for any reason not entrusted with the ownership and management of such vital industries, the State must at least have a controlling voice in the basic policy relating to these industries, and also an effective share in their administration or day to day management. The declaration, for instance, of the Commerce Minister recently, in

regard to the development of the shipping industry in the country,—namely that Government should go into partnership with two or three Statutory Corporations, set up in the several parts of the country to develop rapidly and intensively this industry, on the basis of the State providing 51% at least of the total capital needed, and having a proportionate representation on the Board of Directors and a share in the general management of such a corporation, which would be managed by an existing company as an agent for the State,—is a partial solution which may be accepted even if a truly scientific view of planned development may not find this hybrid or compromise arrangement quite commendable.

In the Summary of Developments that follows, some note is taken of the possibility of development of these industries, and the role they would play in the programme of nation-building from the point of view of intensive industrialisation. It is unnecessary at this stage to anticipate that Summary. Suffice it to say that India has considerable possibilities of her own in the shape of most of the essential pre-requisites of building up such industries in the shape of raw material, skilled labour, capital and State aid where needed; so that, if only a careful programme is drawn up and resolutely executed within a limited period, we may see the growth of that industry, the absence of which today makes us helpless and dependent on foreign supplies both in peace and war time.

K. T. Shah.

REPORT

OF THE

SUB-COMMITTEE

ON

ENGINEERING AND TRANSPORT INDUSTRIES

INTRODUCTORY NOTE

It is very unfortunate that in India vast industrial potentialities exist side by side with a chronic and appalling poverty of the masses.

Non-industrialisation and poverty go hand in hand. In all countries, where there is excessive dependence on land without any corresponding growth in industry, the curse of poverty is inevitable. India's poverty, therefore, is a natural and unavoidable result of her main dependence on agriculture.

That industrialisation is one of the most important methods for the economic redemption of the country, was fully recognised by the early nationalist leaders of India. The Swadeshi movement in the beginning of the present century, gave birth to many indigenous industries. Since then, the process of industrialisation has been slow but steady. Taking into consideration the numerous obstacles which the pioneers had to surmount, the progress in the industrial regeneration of the country has been rather praiseworthy. The little industrial progress that has so far been made in India was made by individual private enterprisers, who, during all these years have been constantly exploring the various possible avenues of industrial expansion, and, in spite of serious natural or unnatural disadvantages, have succeeded in establishing some of the most important and successful industries in the country. So far, Indian industrialisation has never been quickened or fertilised by any definite plan or policy. The present stage of industrial development in the country is the result, not of any organised effort on a national scale, but of mere stray and personal attempts of individual businessmen, who had to fight their way without any active help or encouragement from the State. In the early days of our

industrial awakening, a national plan for industrialisation was never talked of or seriously considered as a practical proposition. The first few decades of the present century was thus a period of haphazard industrial growth, without any plan or programme, unaided by any sympathetic Government policy.

The waves of the far-reaching revolutionary changes in the political and economic structure of society in the post-war Europe, did not, however, fail to reach the distant shores of India, where they were keenly appreciated and very rightly interpreted. The bold experiment at national planning carried out by the Soviet Government in Russia, and the thoroughly rationalised and intensely nationalistic industrial policy pursued with wonderful success by other progressive nations like Germany, Japan and Italy aroused a deep interest among patriotic Indians, who felt that similar methods should be adopted in India for the rapid industrialisation of the country. People were convinced that a Planned National Economy was the only cure for the industrial backwardness of the country. Japan, which was mainly an agricultural country only a few decades ago, has been transformed into a first rate industrial power, as a result of the nationalistic policy pursued by the Government, while Russia, where, until the conclusion of the last Great War, conditions were no better than in India, is at present reckoned to be one of the most industrially advanced countries of the world. India too, as an agricultural country, has hitherto been only a consumer of finished products and the exporter of raw materials. The figures that are usually given to show a balance of trade in favour of India are entirely misleading. The constant drain of Indian money to foreign countries is making the country constantly dependent and poorer. Nothing else than a planned programme of industrial development can effectively stop this continuous and gradual impoverishment of the Indian people, and improve the economic condition of the country.

The nationalist demand for a well-organised and co-ordinated plan for economic advancement of the country was never sympathetically considered by the Government. However, with the coming of the Congress at the helm of affairs, the demand for a National Plan became very persistent and a committee was appointed to formulate a comprehensive scheme for the industrial and economic development of the country.

At present, conditions in India imperatively call for a planned co-ordination of all our productive resources. The

need of National Planning has now become a question of life and death to the nation. No nation can become industrially self-sufficient, until she adopts a definite national plan. If left to their own initiative and resources, Indian industries will never be able to hold their own against the onslaught of powerful foreign competition. India's economic salvation is impossible without a well co-ordinated and thought-out plan for industrial development.

The All India National Planning Committee was appointed by a resolution passed at the conference of Ministers of Industries of various provinces, convened by the President of the Congress, Mr. Subhas Chandra Bose at Delhi, in October, 1938. The committee has been entrusted with the work of formulating a comprehensive scheme of National Planning as a necessary step towards a thorough industrialisation of the country with a view to solve the problems of poverty, unemployment, national defence and economic regeneration of the motherland.

In order to collect the material data necessary for the preparation of a comprehensive plan, the Planning Committee issued a Questionnaire to the various Provincial Governments, Indian States, Universities, Chambers of Commerce, Public bodies, Firms, and individuals.

On account of the vast scope of the task imposed upon it, the National Planning Committee appointed a number of Sub-Committees to investigate and deal with each individual problem separately.

A BRIEF SUMMARY OF THE REPORT

I. Engineering and Transport Industries are divided into three main groups namely:—

1. Heavy Mechanical Industries.
2. Light Mechanical Industries.
3. Electrical Industries.

II. Heavy Mechanical group takes up the manufacture of the following items:—

1. Heavy forgings, castings and spare parts of all descriptions.
2. Boilers.
3. Machine tools.
4. Heavy Machinery of all kinds.
5. Locomotives.
6. Railway carriages and wagons.
7. Heavy Engines.

III. Light Mechanical group deals with the following items:—

1. Motor cars.
2. Taxis.
3. Buses and Lorries.
5. Small engines.
6. Cycles.
7. Aeroplanes.
8. Boats.

IV. Electrical group is further subdivided into two parts; one taking up the manufacture of Generators,—Motors, Transformers, and Control and Switch gear; and the other, the drawing of copper wire and its application to cables and other wire products.

V. For the sake of convenience, in the Report, the Heavy Mechanical Group is designated as the National Workshop while the light Mechanical group as the Automobile Factory.

VI. Taking into consideration the supply of raw materials and the demand, it is recommended that the National Workshop and Electrical Industries be located in Bihar while the Automobile Factory may be located in Bombay,* on an all-India basis.

---

* **Editor's Note.**

Recent developments in the field:

Two enterprises in the Automobile industry have been undertaken:—

VII. Until further increase in the National demand it is strongly recommended that all the items belonging to each of the three groups should be either manufactured in one plant or in interdependent sections or subsidiary units situated in close proximity of one another. This procedure would ensure minimum multiplication of machinery and equipment, increase the efficiency, materially reduce the supervision charges and facilitate co-operative buying, selling and advertising.

VIII. This procedure would materially minimise the initial investment as well as the cost of the finished products by enabling the units to use water, current, steam, compressed air, and even oxygen from the common sources, as far as economical.

IX. It will also enable the utilisation of the bye-products left over by the industrial units.

X. The supervision regarding the buying of raw materials and the selling of the finished products on a collective basis could also be more easily and economically controlled.

XI. It is estimated that the initial investment for all the industrial units would come to about 7 crores of Rupees. The number of men expected to be employed directly would be about 33,000. The labour figures have been purposely kept on the high side as in the beginning at least it is intended not to replace labour by specialised machinery and equipment and intensified division of labour to the fullest extent.

XII. It is suggested that as far as possible all the industries should be owned by the State, but managed by private firms of national repute more or less along the lines of State owned but Company managed Railways.

XIII. The manufacture of motor-cars in India is very strongly recommended. However, until the demand for motor-cars and trucks exceeds 15,000 a year, it is suggested

(1) Hindustan Motors Ltd., and

(2) Premier Automobiles Ltd.

It is understood that Hindustan Motors Ltd. have entered into an agreement with Morris Motors Ltd. of England that the latter would supply automobile experts to set up the factory in India and till such time as we manufacture the parts here itself, Morris Motors Ltd. would supply them for assembling here.

The Premier Automobiles seem to have entered into a similar agreement with Chrysler Corporation of England.

There is a move for the establishment of a factory manufacturing textile machinery in Bombay.

that in order to keep the machinery busy 24 hours a day, Textile Machinery, Small Engines, Cycles and Boats should also be manufactured in the same factory.

XIV. National Engineering Workshop is the basic need of the country in order to manufacture Machine tools and Heavy Machinery.

XV. No provision is made for the manufacture of pig iron and steel. The semi-finished product should be brought from the existing steel Companies namely, The Tata Iron & Steel Co., and the Bengal Steel Corporation Ltd.

XVI. In order to encourage the capitalists to invest money, it is suggested that the Government should guarantee certain interest for at least 10 years on the paid-up capital. On an investment of 7 crores of Rupees the guaranteed interest will not exceed 20 lakhs of Rupees a year.

XVII. In the beginning it will be necessary to import convenanted hands or experts from abroad. However, in order to ensure the training of Indian staff, it is strongly recommended that the convenanted hands employed must be contracted on the basis of fixed monthly salary and fixed lump-sum bonus. They would be entitled to the bonus only at the termination of their contract, provided they have fulfilled the condition of properly training up Indian assistants under them.

XVIII. The selling end of an article being far more important than the manufacturing end, it is recommended to manufacture at first only those articles for which there is a guaranteed demand from the Central Government, the Military, The Railways, the Provincial Governments and leading Industrial firms in India.

XIX. The Scheme would provide food, clothing and shelter directly and indirectly for about 3 lakhs of persons. Monthly wage bill would amount to 15 lakhs of rupees.

XX. The building should be designed to suit the equipment and lay out machinery and not vice versa. Adequate provision must be made for expansion.

XXI. In order to tie up the minimum amount of capital in inventory, as far as possible, all the equipment, machinery conveyors and cranes should be of the same size, make and design.

XXII. In order to avoid cut-throat competition and over production, no manufacturing plant should be allowed to be started in India without the consultation of, and com-

ing to a mutual agreement with, the owners of the present industries, large or small.

XXIII. National Industries should be utilised for the training of the Indian youth for industrial career.

XXIV. The Control laboratory and its staff connected with the National Workshop should assist all the small prospective and existing manufacturers with all the necessary technical information.

XXV. Advantages to the Government:—

1. Part solution of the unemployment problem.
2. 50 per cent of the net profit.
3. Railway freight to the extent of one crore of Rupees per year.
4. Material solution of the National defence.
5. Loss of revenue, if any, can be met from excise duty.

XXVI. Government support is essential particularly in the following directions:—

1. Revision of the Government of India Act of 1935.
2. Financial help in the initial stages of Industrial development.
3. Establishment of Labour Industrial Council.
4. Transport facilities.
5. Tariff Protection.
6. Administration.
7. Sales organisation.
8. Standardisation.
9. Internal competition.

ESTABLISHMENT OF ENGINEERING INDUSTRIES INCLUDING TRANSPORT INDUSTRIES AT A COST OF 7 CRORES OF RUPEES, PROVIDING FOOD, CLOTHING AND SHELTER DIRECTLY AND INDIRECTLY TO AT LEAST 3 LAKHS OF PERSONS IN THE COUNTRY.

I. Total number of persons expected to be directly and indirectly benefited through the establishment of National Workshop, Automobile Factory, Wire and Cable Company and Electrical Manufacturing Plant:

(*a*)	Skilled	11,365
(*b*)	Unskilled	19,855
(*c*)	Supervising staff	1,625
(*d*)	Specialists	153
	Total (nearly) ..	33,000

II. Educational facilities for 25,000 boys and girls: 2 High English Schools, 8 Middle English Schools, 10 Night Schools, 50 Primary Schools and one Technical Institute.
Total Number of teachers employed 600

III. **Medical Department.**

Doctors		60
Nurses		45
Dentists		5
Compounders, dressers and ward boys ..		90
Total ..		200

IV. **Contractor's Labour** 5,000

V. **Public Health.**

Chief Medical Officer of Health	1
Sanitary Inspectors	50
Mokadams	50
Sweepers	1,000
Total ..	1,101

VI. **Police and Guard Force** 400

VII. **Post and Telegraph Staff** 100

VIII.	**Court staff and lawyers**	100
IX.	**Public Works Department**	200

X. **Miscellaneous Trades and Professions**

25	Coal and Coke depots	100
30	Wood and Timber depots	300
5	Soapworks	50
5	Flour Mills	50
5	Soda Water Factories	50
2	Ice Factories	20
10	Brick Fields	300
5	Printing Press	100
5	Banks	100
10	Insurance Offices	50
5	Co-operative societies	20
3	Opticians	9
100	Taxis	200
50	Buses	100
50	Lorries	100
20	Potteries and Earthenware	100
10	Laundries and Washermen	100
	Total	1,899

XI. **Shops:—**

110	Cloth	330
200	Groceries	900
20	Cycle and repairing Shops	100
10	Book shops	30
60	Stationery, Oilmen, Chemists and Druggists	120
32	Shoes	64
175	Metals, Restaurants, Confectioners and Bankers	1,925
15	Fish	45
60	Meat	240
50	Fruits	200
100	Vegetables	400
60	Goldsmiths	120
10	Brass & Aluminium	40
10	Hardware	40
125	Tailors	480
75	Godowns	500
200	Miscellaneous	2,000
	Total	6,714

Total number of persons engaged	49,274
XII. Number of dependents at the rate of five persons per every man engaged.	2,46,370
XIII. Total Number of persons provided with food clothing and shelter	2,95,644

N. B.:—The above figures take into consideration neither the additional labour employed by the suppliers of raw or semi-finished materials nor labour involved in Railway or Road transportation.

CHAPTER II.

SUITABILITY OF BOMBAY FOR LIGHT MECHANICAL INDUSTRIES

Automobile Factory

1. The Automobile industry is, what is known as an "intermediate" industry, that is, one whose success depends on favourable connections with the producers of processed materials, mainly iron and steel, either in the local or 'competitive' markets and secondly on the ability to sell at an advantage in the local or national markets at competitive rates. It is an industry in which the proximity to a local market, the availability of the initial and working capital and facilities for distribution are more important than the nearness to raw materials.

2. Bombay is the only Province in India where the capital is in the hands of the Indians. Practically all the major industries, banking facilities, business and other trades are being conducted by Indians. Bombay undoubtedly has produced and supplied to the Indian Nation a larger number of business magnates than any other Province.

3. The annual consumption of motor cars and trucks in India amounts to 15,000. This figure is not high enough to justify the manufacture of motor cars and trucks alone but should also include those items for which the motor car manufacturing machinery can be utilised with slight modifications. Such items as already suggested are:—

1. Textile machinery,
2. Light internal combustion engines,
3. Agricultural machinery and implements,
4. Cycles,
5. Boats,
6. Tractors,
7. Aeroplane parts,
8. If necessary, steel furniture, metal ware and hardware goods both for house-hold and builders' trade.
9. Cutlery.

Thus the search for a market should not be centred around motor cars and trucks alone, but should also include the above-mentioned items.

4. One of the chief advantages of Bombay is the wide local market. Because of the large number of textile mills, engineering workshops and other diversified industries, it is the largest consumer of motor cars, trucks and boats at present.

5. Besides an excellent local market, Bombay is admirably situated as a distributing centre for machinery, cars, trucks, machine and mill works, hardware goods etc. Its nearness to Ahmedabad, the centre of the cotton industry and other important towns has made it the most important distributing centre. The annual import of textile and cotton machinery alone amounts to 270 lakhs of rupees.

6. Being the most important sea port in India, and being centrally located, Bombay commands both land and sea transport facilities for the whole of India. Its total annual imports amount to an impressive figure of Rs. 5,000 lakhs. It also has an added advantage of a competitive market for buying the iron and steel products and other raw materials.

7. In foreign countries motorable roads have played an important part in the shipping of finished motor cars. Railway transport has been practically eliminated. A special truck provided with trailers is commonly used for the transportation of several cars at a time. Bombay has a beautiful network of real good roads leading to all the main cities in India.

8. It is an admitted fact that more trained labour, having practical experience in precision work as required in Automobile industry, is available in Bombay than elsewhere. This is partly due to the fact that a motor assembly plant, railway workshop, ship building and other engineering workshops have already been established there.

9. It is suggested that carbon steel billets and sheets be bought from the existing iron and steel companies, and re-rolled into finished sections according to our requirements in the factory. A motor car requires alloy steels of about 25 different specifications. For a long time to come there will not be enough demand for such steels to induce the existing iron and steel factories to manufacture them economically, in large quantities. Provision has been made to make the alloy steel locally in electric furnace using hydro-electric power. The consumption of coke, another raw material required, is small, since it would be used only

to produce cast iron of special analysis from pig iron, in cupolas. In case of necessity cupola melting can also be replaced by electric furnace melting. Besides it is intended to build up the industry in steps and it would be necessary at least in the beginning to import some of the parts and special machinery etc., from Europe or the United States. This is another point in favour of the port of Bombay as compared to other places.

10. Plenty of cheap hydro-electric power is available at present from the Tata Hydro-Electric Agencies Ltd., and since most of the machinery and operations are to use electric power the proximity to coal is not an important factor. So far, adequate means and methods for consuming the surplus load in Bombay have not been found, and the establishment of industries seems to be the most logical solution.

11. Among the other advantages, Bombay has an abundant supply of water both for industrial and domestic use. An equitable climate throughout the year is also an important point since it has been found that in places with extremes of climate there is a fall in production in summer.

12. The benefits which accrue to a nation from the automobile industry can be gauged from the following figures given by Mr. J. H. Van Deventer, Editor of the **Iron Age,** in his article entitled "What Machines are doing to Automobile Workers", which appeared on June 9, 1938, in the **Iron Age.**

13. The population of Detroit and its suburbs, which may be regarded as typically automotive cities in America, was 3,66,000 towards the turn of the century. Since the establishment of the automobile industry, the population has increased five-fold during the last 38 years standing at over 2 millions today, while during the same period the population of Buffalo, Cincinnati, Chicago and New York has only increased three-fold.

14. It is also a matter of interest, Mr. Deventer adds, that whereas the gold fields of South Africa, which are the richest in the world, have produced a total value in gold of approximately 7 billions of dollars, the automobile industry has generated 84 millions of dollars in the shape of wages for 38 years and provides employment to one in every seven workers usefully employed in the United States.

CHAPTER III.

PROCEDURE TO BE ADOPTED TO MANUFACTURE MOTOR VEHICLES IN INDIA

In order to use the same engine for both, it is suggested to make 24-28 H. P. car and a truck similar to Ford V-8, Chrysler or Chevrolet. In the initial stages, it may be necessary to keep in touch with the chief automobile manufacturing firms of the United States of America, England, or of the Continent; use foreign models and designs; and engage foreign experts and consulting engineers; but eventually a time is bound to come when having gained sufficient experience, Indian labour will be able to pilot this industry to success through independent endeavour.

In Europe and in the United States of America, the keynote of success in this field has been intensive specification in individual parts and accessories necessary in the manufacture of automobile. They are made in small factories or workshops which concentrate on the production of one or two parts only, thus acquiring a degree of skill unattainable in a factory with scattered energies. The automobile manufacturer himself may produce many of the parts or a few, or he may purchase from individual makers and undertake only their final assembly, there being not a single factory in existence which makes more than 75 to 80% of the parts on its own premises.

Although many of the foreign markets obtain most of the parts in the shape of crude castings and forgings from outside foundries and forge shops, and have them treated, machined and assembled in a Central Factory, in India, it is essential to make adequate provision for the manufacture of alloy steel, cast iron and non-ferrous parts of different specifications, as the efficiency of Indian foundries and forge shops now in existence is not good enough to cope with the demand of the automobile industry for quality castings and forgings.

Regarding the establishment of an Automobile industry in India it can be safely said that 75% of the job is finished after one is in possession of all the detailed blue-prints of the component parts of a car and truck together with patterns, dies, jigs and fixtures required to make them.

There is no dearth of raw materials, general engineering ability and mechanical knowledge to manufacture a car and a truck profitably in India. In the beginning a little lead from foreign automobile experts engaged as consultants (as done in Japan) may be necessary to start the ball rolling, otherwise the entire job can be handled by Indian Engineers. Ordinary Bombay Khalasies or Punjabee Mistries getting one to two rupees per day can be taught to do the same job as men getting ten to fifteen rupees per day are doing in the United States, England, or the Continent. This is particularly true of labour such as employed in an automobile factory.

In the opinion of the Committee the following are the four possible methods of starting an Automobile Plant in India:

1. To import Automobile Engineers in the form of covenanted hands on at least three years' contract and prepare complete blue-prints of all the parts of the car as well as patterns, dies, jigs, fixtures etc., in India.
2. If possible, to buy complete blue-prints of a foreign car and manufacture the same in India with Indian materials, labour and 98% Indian supervision, starting, of course, with an assembly plant.
3. If possible, to buy complete blue-prints of all major assemblies from various foreign concerns which have specialised in them and then gradually manufacture the component parts of each assembly and eventually build the car, almost the entire car, in India.
4. To establish a temporary Engineering Office in a country, preferably in the United States of America, and submit to them general specification regarding gasoline consumption, horse power, number of cylinders, body design, wheel base or any other characteristic feature to Indian idiosyncracies or conditions; ask the office to design a car and send us complete blue-prints regarding the layout, equipment, dies, jigs, fixtures, conveyers, etc., required to manufacture a car and a truck at minimum cost. In the beginning import all component parts and only assemble cars in India.

In the Committee's opinion No. 4 would be the best, cheapest, quickest and the most efficient method to adopt. United States leads the world in the design and production methods. Information which can be obtained in a city like

Detroit in one day would be hard, if not quite impossible, to collect in India even with the help of several foreign automobile experts in six months' time. Furthermore, what we will be able to accomplish by spending fifty or seventy five thousand rupees we will not be able to get in India even by spending five to ten lakhs.

There are about 40 makers of parts and major assemblies in Detroit, the chief centre of the automobile industry in U.S.A. who have invested in the aggregate a sum of over Rs. 550 crores in their works and supply many parts and accessories to the manufacturers of cars and trucks as well as to private owners according to their designs and requirements. The following are a few examples of such specialists:—

1. **Engine**
   (a) Continental Motor Corporation, Detroit.
   (b) Arrow Head Steel Products Co., Minnoapoles.
2. **Front & Rear Axles**
   (a) Timkin Detroit Axle Co., Detroit, Mich.
   (b) Flint Motor Axle Co., Detroit, Mich.
   (c) Lansing Drop Forge Co., Near Detroit Mich.
3. **Radiators**
   Mc.Cord Radiator and Manufacturing Co., Detroit, Mich.
4. **Body**
   (a) Brigs Manufacturing Co., Detroit, Mich.
   (b) Fisher Body Corporation, Detroit, Mich.
   (c) Murray Body Corporation, Detroit, Mich.
5. **Wheels**
   (a) Kelsey Wheel Co., Detroit.
   (b) Hays Wheel Co., Detroit.
   (c) Motor Wheel Co., Lansing, Michigan.
6. **Gears, Pinions and Transmission**
   (a) American Gear Co., Jackson Mich.
   (b) Gleam Works, Rechester, N.Y.
   (c) Cleveland Worm & Gear Co., Cleveland, Ohio.

It is said that at the present time the maximum consumption of cars and trucks of all different makes does not exceed 15,000.

This fact must not stand in the way of establishment of a company. A car is no longer a luxury but a necessity. About 15 years ago you would have said the same thing about other countries. The demand in India must be created as it has been done in Europe, the Continent and Japan.

Furthermore, car is a perishable article good only for about 7 years and consequently there is no fear of reaching the saturation point. As India becomes more and more industrialised and consequently prosperous, the demand for car is bound to go up. Mr. Henry Ford once remarked to a salesman who approached him and told him about 25 years ago that the demand for Ford Car was decreasing and that it had practically reached the saturation point: "Well, you are paid for creating the demand. The Ford Motor Co., will increase efficiency and cheapen the car but will never curtail production. There is no word as lack of demand or saturation point in an Automobile Industry."

All that is required is to get the automobile industry started in this country in a spirit of enterprise, a business capacity and the desire to go ahead and be abreast of the rest of the civilised world. The establishment of an Automobile Industry in India amounts to the discovery of a Gold Mine in the country.

Metallic Requirements of a Motor Car

The Chassis weighs between 16 and 18 cwt., while the completed car between 1¼ and 1½ tons. The weight of the alloy steel in a car is confined almost entirely to the chassis and does not exceed 30% of the chassis weight. 4500 tons of billet or bar stock or 6250 of ingots would be required to manufacture 15000 cars and trucks per year. Major portion of the straight carbon steel is also contained in the chassis frame, brake-rods, pedals, wheels, body sheets, pressings, bolts, nuts, etc. Modern car bodies are almost entirely made of sheet steel and pressing of straight carbon steel. Here, it must be mentioned that in order to obtain desired deep drawing qualities and good finish, additional normalising, pickling and cold-drawing operations would be required for body and tender sheets. A company making only black or galvanized sheets in India must take the above mentioned fact into consideration.

Approximate weight tonnage of alloy and straight carbon steels of special quality required for 15000 cars and trucks.

Alloy Steel	6,250 tons.
Spring Steel	400 ,,
Body sheets and pressings	5,000 ,,
Chassis frame	5,700 ,,
Carbon steel for rods, pedals & other minor parts	Balance.

An idea of materials used in a 24-28 H. P. Motor car

1.	Steel cold drawn & hot rolled	1,800 lbs.
2.	Iron, malleable and cast ..	600 ,,
3.	Rubber	100 ,,
4.	Cotton	70 ,,
5.	Glass	65 ,,
6.	Brass	28 ,,
7.	Lead	25 ,,
8.	Wood	20 ,,
9.	Pure Copper	18 ,,
10.	Wool	5 ,,
11.	Miscellaneous	59 ,,
		2,800 lbs.

Analysis of cost in an American Automobile Plant

	Rupees
Labour	300
Materials	750
Overhead	210
Total ..	1,260

The list of price or market price is about 45% more, say, about Rs. 1800/-.

Production cost in U.S.A. of a medium passenger car of 24-28 H. P.

		Dollars.
1.	Wheels and springs	27
2.	Frame	10
3.	Tyres & Tubes	30
4.	Axles including differential	65
5.	Gear Box	26
6.	Engine and clutch	75
7.	Body	95
8.	Radiator	16
9.	Electric Equipment ..	30
10.	Mudguards, Bonnet and other metal parts	22
11.	Lamps and Horns	6
12.	Miscellaneous accessories	8
		410
13.	Assembly and Misc., charges	60
	Total ..	470

Production cost and selling price of an American 27 H. P. car in India

	Rs.
American cost ex-works	1,260
Packing and freights up to New York ..	176
Ocean freights	246
Sea insce.	11
Import duty in India at 37½%	638
Port Trust charges, clearing and delivery in Bombay	59
Add one-third to gross profit to dealer and for local delivery and service charges ..	800
Total ..	3,190

Estimated costs of finished car parts ready to Assemble in India

I. Parts to be manufactured in the Central Factory:—

		Rs.
1.	Body	499·50
2.	Axle Rear and Front	94·50
3.	Clutch	9·31
4.	Transmission gear Box	66·20
5.	Engine	256·36
6.	Steering Gear	14·14
7.	Brakes, Hand and Foot	38·90
	Total ..	978·91

II. Parts to be made in the Central Factory or the subsidiaries or to be imported as conditions permit:—

8.	Chassis, frame, mud-guard, hood, etc.	102·60
9.	Wheels and Tyres	114·10
10.	Petrol equipment	14·25
11.	Electrical parts	72·30
12.	Radiator	35·61
13.	Instruments and tools	19·41
14.	Springs	34·42
15.	Bumpers	10·38
16.	Propeller shaft	10·35
17.	Exhaust pipes and muffler	4·88
18.	Lubricants	3·80
19.	Paints	16·17
	Total ..	439·27
	Grand Total ..	1418·18

CHAPTER IV.

APPROXIMATE COST OF MACHINERY AND EQUIPMENT INVOLVED IN THE MANUFACTURE OF MOTOR CARS AND ALLIED LIGHT MECHANICAL MACHINERY IN BOMBAY

Annual import of items under reference in lakhs of rupees.

1.	Motor cars and taxi cabs	243
2.	Parts	74
3.	Chassis	188
4.	Motor Vans, Lorries and Omnibuses ..	13
5.	Tractors and ploughs	12
6.	Cycles and parts	11·2
7.	Motor Cycles	3·5
8.	Ships parts, launches and boats ..	4
9.	Cotton Mill machinery	180
10.	Jute mill machinery	74
11.	Woollen mill machinery	16
12.	Light Engines and parts (Approx.) ..	40
13.	Aircraft and parts	16
	Total annual imports	804·7

Capital Outlay

		Rs. in lakhs.
I.	Land, building and quarters	14
II.	Power Station and Distributions	4
III.	Main Production Departments (Motor) ..	
	1. Foundries :—	
	a. Cast Iron	5
	b. Non-Ferrous alloys	1
	2. Forgings and springs manufacture ..	5
	3. Heat Treat	2
	4. Machine shop	20
	5. Pressed steel	22
	6. Assembly and Testing	20

IV. Nonproduction departments for automobile as well as parts of other machinery under reference.

1.	Control and metallurgical laboratory	2
2.	Timber yard, carpenter shop, pattern shop and vault	4
3.	Jobbing Foundry :—	
	1. Cast iron	18
	2. Permanent mould	2
	3. Steel	2
	4. Malleable cast iron	3
	5. Non-ferrous alloys	1
	6. Die casting	2
4.	Blacksmith shop	8
5.	Tool room and die department including Heat Treatment	6
6.	Structural shop cutting and welding and pipe	4
7.	Transportation Facilities	4
8.	Electric Furnace for alloy and straight carbon special steel ingots and castings	4
9.	Rolling Mill equipment	14
10.	Machinery equipment or furniture for miscellaneous as general office, drafting room, engineering, first aid, paint shop, steam & air chemical laboratory, rubber and bakelite, battery manufacture (if necessary), Electroplating, scrap and salvage employment, shipping sales, etc. ..	15
11.	Miscellaneous	10
12.	Working Capital	80
	Total in lakhs of Rs. ..	300

N.B.—1. The scheme includes the cost of cranes and conveyors.
2. Cost figures are purposely kept on the high side.

CHAPTER V.

SUITABILITY OF BIHAR OR BENGAL FOR THE ESTABLISHMENT OF HEAVY MECHANICAL (NATIONAL WORKSHOP) AND ELECTRICAL INDUSTRIES

1. Bihar is a specially favoured Province by nature. As compared to its size and population, Bihar is richer than any other province in its resources, mineral and agricultural. From the point of view of the proximity of raw materials, adequate water supply, availability of trained labour, transportation facilities, cheap electric power, supply of pig iron and steel products, Bihar is indisputably the most suitable Province in India for the establishment of all Heavy Mechanical and Electrical Industries.

2. Bihar is the only Province in India which contains practically all the necessary natural resources namely iron ore, coal, limestone, dolomite, refractories, copper lac, aluminium ore, mica, etc., so essential for the establishment of the above mentioned key industries and their subsidiaries.

3. The agricultural pursuits include not only rice, wheat, barley, maize, oil seeds, sugar cane, tobacco and other indigenous food stuffs, but the Province is rich in growing non-food crops such as jute, indigo, and early cotton.

4. As for the mineral resources, coal, the most essential material for any kind of industry, is found in Dhanbad, Giridih and Jharia. In 1936 Bihar's production of coal represented about 56% of the total production in India. Iron ore which is the basic material for the industries recommended is extensively found in Singhbhum district. In fact these mines produce nearly the whole of the iron ores in India. Limestone is available in the district of Palaman, Singhbhum, Jangpur, Santhos Parganas and Shahbad. Copper ore, the source of another indispensable metal for the industries is stocked near Ghatsila in Singhbhum District. Mica, one of the most important materials for electrical industry is quarried in the Hazaribag and Gaya districts, while Chota Nagpur District is the greatest producer of Lac in India. Aluminimum Corporation of India Ltd., has been organised for reduction of bauxite pits and manufacture of aluminium pig and sheets at Dehri-On-Sone.

5. There are at present nearly half a dozen up-to-date iron and steel factories operating in India; of these the Tata Iron and Steel Co., Ltd., which has its factory at Jamshedpur in Singhbhum is the largest. With rich deposits of iron ore in Singhbhum and in the adjoining native states, with extensive lime deposit suitable for use as flux in metallurgical operations, and the proximity of coal fields, Jamshedpur occupies a unique position in the industry. Tata Iron and Steel Co. obtains iron ores from Kolhan in the Singhbhum district and from Mayurbhanj. Limestone is obtained from Panposh, a railway station near Chakradharpur and from Rajganjpur and coal from Jharia and Raniganj coalfields. The company produces pig iron, steel rails, joists, angles, tees, plane and galvanized sheets, etc. During the year 1937-38, pig iron output of India rose to 1.64 million tons, out of which 921,000 tons were produced by the Tata Iron and Steel Co., Ltd., alone. Jamshedpur with her chief, the Tata Iron & Steel Co., Ltd., and her various subsidiaries can be rightly called the Pittsburgh of India.

A general idea of the annual contribution of Jamshedpur or Tatanagar towards the industrialisation of India is as follows:—

1. Tata Iron and Steel Co., Ltd.

Coke	800,000 tons.
Pig Iron	900,000 ,,
Ferro manganese	8,000 ,,
Steel Ingots	90,000 ,,
Blooms, billets.	
Slabs (*a*) Semi-finished	8,000 ,,
(*b*) Finished	77,000 ,,
Tin flat slipper bars etc.	78,000 ,,
Sheet and slipper bars	
(*a*) Semi-finished	138,000 ,,
Rails and Structurals	152,000 ,,
Bar and merchant mill material ..	175,000 ,,
Plates	63,000 ,,
Black sheets	25,000 ,,
Galvanized plain sheets	15,000 ,,
Galvanized corrugated sheets ..	79,000 ,,
Sleepers	2,000 ,,
Iron and Steel castings	28,000 ,,

2. Indian Cable Co., Ltd.

This factory is located at Tatanagar. They are at present manufacturing the following articles:—

1. Dynamo and instrument wires.
2. Coloured cab, tyre sheathed cables.
3. Super trop cables.
4. Aluminium wires and stranded conductors.
5. Copper wires and stranded conductors.
6. Indian Cable flexibles.
7. Tough rubber sheathed cords and trapping cables.
8. Copper belt wire.
9. Rubber insulated, tape braided and compounded cables.
10. Lead, alloy-earthed cables for house wiring.

From information collected, it appears that the Company manufactures approximately 200 thousand yards of wire weekly. Copper is imported and the cotton used is purchased from South India.

3. Tata Iron and Steel Co., Ltd., Agrico Department

This company is also located at Jamshedpur. They are manufacturing the following articles:—

(1) Kudals 3¾ million, (2) Pick Axe of various kinds 2½ lacs, (3) hammers and miscellaneous tools 1¼ lacs, (4) high class carbon oxygen for working into chisel 750 tons a year.

4. Steel Wire Products: Jamshedpur:

The company are manufacturing all kinds of wire viz. galvanised barbed wire, wire nails, rod bars, etc.

5. Tinplate Co. of India:

The Company manufactures tin plates of all sizes and gauge. Billets are purchased from the Tata Iron and Steel Co. The annual production is 5,000 tons. This company also manufactures sulphuric acid for its own consumption as well as for the use of some other subsidiary companies. Daily production is about 10 tons.

6. Indian Copper Corporation Ltd., Ghatsila:

They are manufacturing copper ingots to the extent of 550 tons a month and brass sheets and brass shuttles to the extent of 800 tons a month.

Other subsidiary Companies at Jamshedpur are:—

(1) Tatanagar Foundry Co.
(2) Jamshedpur Engineering and Machine Mfg. Co.,
(3) The Tatanagar Chemical Co.
(4) The Indian Hume Pipe Company.

On account of the presence of Railway Workshop at Jamalpur, B.N.R. Workshop at Kharagpur, and Tata Iron and Steel Co. with her various subsidiaries in Tatanagar, plenty of skilled labour at present is available in this part of India.

The strategic places for location of Industries which involve important manufacturing and distributing functions are points on competing water ways, centres at which numerous competing railways converge and good metalled and unmetalled roads run to and from. Looking at the map of India it will appear that Bihar is the only Province which can boast of possessing centres with such facilities jointly. As freight plays an important part in calculating the cost price, this factor cannot be passed over easily.

The E.I.Ry., B.N.Ry., B. & N.W.Ry. etc., are the chief railways in Bihar. There are about 4,000 miles of railways in the province besides 4,000 miles of metalled roads and about 26,000 miles of unmetalled roads. There are about 500 miles of navigable canals.

At this stage, it is necessary to talk a little about the proposed Electrification of Bihar using low grade coal. It is learnt that the scheme as modified by the Committee of Experts has been accepted by the Government and every effort is being made to take up the scheme as soon as possible. It is understood that they are at present having two power stations of 15,000 K.W. each; one at Jumuniatand, and the other at Gaya. As the two Power Houses will be inter-linked, there seems to be no doubt in continuity and reliability of the services at cheap rate.

In spite of the fact that iron and steel, manganese, copper, chromite, mica and everything else required for the manufacture of machinery are available in Bihar or her vicinity, machinery and mill work worth 13 to 14 crores of rupees are annually imported into India. In order that India may industrially develop and occupy a prominent position among the industrially developed countries of the world, it is essential that immediate steps should be taken for the establishment of a national workshop and all major Electrical Industries.

The claim of Bengal particularly that of Calcutta area on account of her Railway and Seaport facilities and availability of cheap and plentiful labour, electric current, coal and other natural resources (Bihar) must also receive the consideration in selecting the location for the establishment of heavy mechanical industries.

CHAPTER VI.

APPROXIMATE COST OF MACHINERY AND EQUIPMENT INVOLVED IN THE MANUFACTURE OF HEAVY MECHANICAL MACHINERY ON AN ALL-INDIA BASIS IN A NATIONAL WORKSHOP IN BIHAR

Import of items under reference during the year 1936-37 in lakhs of Rupees.

1.	Metal working machinery including machine tools and others.	30.0
2.	Railway Locomotives.	76.0
3.	Other Locomotives.	13.5
4.	Heavy Engines	43.0
5.	Railway carriage wagons and parts.	65.0
6.	Boilers.	87.0
7.	Mining.	73.5
8.	Oil crushing and refining.	27.5
9.	Paper Mill	7.8
10.	Pumping.	30.5
11.	Rice and Flour Mill.	71.0
12.	Saw mill and wood working	45.2
13.	Sugar machinery.	95.1
14.	Tea	14.7
15.	Printing and Lithographic presses	18.2
	Total in Lakhs of Rupees	676.5

Capital Outlay in Lakhs of Rupees.

1.	Land, Building, and Quarters	30
2.	Power House	50
3.	Control and Research Laboratory	4
4.	Pattern shop and Vault	4
5.	Jobbing Foundry:	
	Cast Iron	8
	Steel (acid) ingots and castings	4
	Non-Ferrous alloys	1
6.	Blacksmith Shop (Heavy Forgings)	10
7.	Tool and die Dept. including Heat Treatment	6
8.	Structural Shop including culling and welding	10
9.	Seamless Tube Mill	30
10.	Machine Shop (Complete)	50
11.	Inspection Department	4
12.	Transportation Facilities	8
13.	Machinery, equipment or furniture for miscellaneous department such as general office, engineering office, drafting room, first aid, electroplating, shipping, steam, oxygen, water and air upply	20
14.	Working Capital	80
	Total in lakhs	319

A general idea of the equipment and machinery required for the machine shop of the heavy mechanical industries.

Lathes

6	Lathes	6″ to 7″	centre,	2′ to 6′ long.
7	,,	8″	,,	3′ to 10′ ,,
5	,,	8·5″ to 10″	,,	3·5′ to 17′ ,,
6	,,	10·5″ to 11″	,,	4′ to 11′ ,,
9	,,	12·5″ to 15″	,,	11′ to 19′ ,,
9	,,	16″ to 18″	,,	10′ to 22″ ,,
6	,,	24″ to 30″	,,	8·5′ to 30″ ,,

Turret Lathes

5—2¼″—2½″ Capstan Turret Lathes with 18″ to 20″ swing.
3—Hollow Spindle Lathes, 18″ x 3¾″ x to 3½″ x 40″.
1—10″ Centre, 3′ long Turret Lathe.
1—No. 6 Foster Turret Lathe with 20″ swing.

Boring Machine

4—Horizontal boring machine—Table size 5′ x 3.5′ to 23′ x 15′ with up and down motion 18″ to 30″.
11—Vertical boring machines with table diameters from 2″-3″ to 5′ and up and down motion, 1-4″ to 6′.
4—Verticle boring Machine, table diameter from 10′ to 15′, up and down motion of 5′-8″ to 7′.

Slotting Machine

6—Slotting Machines, table diameter from 24″ to 48″, up and down motion of 6″ to 24″.

Milling Machine

4—Milling Machines 6.5″ to 2′-5″ centre and 3′ long.
1—Universal Milling Machine, spindle diameter 2¼″, Table 29″ x 12″, and 18″ high.

Gear Cutting Machine

1—Keyway Gear Cutting Machine.
5—Bevel Gear Cutting Machines, size 24″ to 54″.
1.—Spur Gear ,, ,,
1—Vertical Gear ,, ,,

Die Machines

3—Die Punching Machines, from 3/8″ to 3″.

Grinding Machines

8—Grinders, wheel diameters from 3″ to 1′-4″ and thickness from ¾″ to 1.2″.
1—Universal Grinder, 10″ wheel diameter, 2″ thickness.
1—Single Grinder, 18″ x 2″.
2—Double Grinder, 18″ x 2″ and 18″ x 3″.
1—Twist Drill Grinder.
1—Grinder, size 17″ centre, 9′ long.

Drilling Machines

12—Radical Drills—5' to 9' radius, Max, drill diameter 3".
2—Vertical drills, maximum size of drills, 5/8" and 1½".
2—Corona Sensation Drills.

Screwing Machines

1—Screwing Machine for 1½" bolt.
1— „ „ 4" to 8" Pipe.
1— „ „ ¼" to 4" Pipe.
1—1¼ Lams Secrewing Machine.

Shaping Machine

14—Shaping Machines, Table sizes from 16" x 21" to 32" x 20" with strokes from 18" to 24".

Planing Machines

1—Side Planer, Table 14' x 6'-3½", up and down 6'.
1—Backton Planer, travel E & W. 13', up and down 8'.
1—Morton Planer, travel N. & S. 6', E. & W. 18' up and down 7'.
2—Sunderland Spur & Spiral Planers.
7—Planing Machines, table sizes from 36" x 36" to 8'-4" x 20', up and down motion from 22' to 7'.
6—Planing Machines, table sizes from 17' x 3.5' to 20' x 9'-9", up and down motion from 4' to 9".

Saws

6—Saws of various kinds.

Miscellaneous

1—Centering Machine, 8" grip, 16' long.
1—Electric Hammer, 8" diameter.
2—Cutter and Grinders for Sunderland Spur and Spiral Planer.
3—Drilling and Key-way Seating Machine.

CHAPTER VII.

A GENERAL IDEA OF MACHINERY AND EQUIPMENT WHICH IS MORE OR LESS IDENTICAL TO BOTH HEAVY AND LIGHT MECHANICAL INDUSTRIES

1. Structural Shop.

Building
Welding Equipment
Cutting Machine
2 Saws—36" & 42"
Radial Drilling Machine
6 Shearing & Punching
2 Plate Bending Machine
2 Electric Rivet Heating Machines
Compressed Air Equipment
3 Cranes—10/Ton
and
2 Cranes—20/Ton each.

For the Light Industries, Number and Capacity of the overhead cranes can be considerably reduced.

2. Blacksmith Shop

1.	1,000-Ton Press.	1
2.	3-Ton Crane Manupulator	1
3.	2-Ton Steam Hammers	3
4.	1-Ton „ „	2
	80-lb. Cushioned Bradley Hammer	1
5.	Electric Welders	2
6.	Acetylene Burner	1
7.	Forges and Anvils	1
8.	Ingot Heating Furnace	12
9.	Furnace for heating up 25-Ton	1
10.	Car Type Furnace capable of heating up 25-Ton Forgings—Provided with Oil Circulating Pit	1
11.	Oil and Water Tanks for Quenching	1
12.	Newton Saw 16" Wheel	1
13.	Double Grinding Machines	2
14.	Drilling Machine (Radial)	1

3. Pattern Shop

1. Two Drilling Machines—Vertical.
2. One Drilling Machine—Horizontal.
3. Planing Machine.

4. Surfacing only 18" cutter.
5. Thicknessing only 24" cutter.
6. Combined surfacing and Thicknessing—24" Cutter.
7. Lathe 3'-6" centre.
8. Lathe 2' centre x 12' Bed.
9. „ 9" centre x 6' „
10 Two Jointers 6" Cutters.
11. Circular Saw 30" dia.
12. „ „ 27" „
13. Band Saws 2'-5" & 3'-5" dia.
14. Wood Trimmer.
15. Grinding Stone 2"-6".
16. Wood Milling Machine.
17. Sand Paper Machine.
18. Steam Driven Log-Sawing Machine. Capacity 3' x 2' long.
19. Circular saw 3' dia.
20. Circular saw 2' "

4. Cast Iron, Steel, Brass and Malleable jobbing Foundry

1.	Coupolas 72" Shell	2
2.	Blowers to suit	2
3.	Core Ovens	
	Car Type 12' x 16' x 9'	1
	Drawers Type	3
	Five Ton with independent portable core racks	1
4.	Five Ton Elevator for cupolas	1
5.	30" Grinders	2
6.	Five Ton Scale	1
7.	Barrel trucks	2
8.	Cargo trucks	2
9.	Wheel Barrows	20
10.	Tumbler	1
11.	5/Ton Electric Furnace	
12.	2 Mould Drying Ovens Car Type	
13.	2 Annealing Furnaces—Car Type	
14.	50/Ton Cranes	2
15.	15/Ton Cranes	2
16.	12 Crucible holes provided with stack	
17.	Cupola Tools	
18.	Melting Furnace 1-Ton charge (Malleable iron) (White cast Iron)	
19.	Annealing Furnace—Capacity 3/Ton Castings.	

5. Metallurgical, Control and Testing Department

1. Hoskins Hair Pin Type. Resistence Furnace for F. B. 207.
2. Leeds and Northrup Thermal Curve Automatic Recorder.
3. Combined Polishing and Grinding Wheel.
4. 3—Oil Tanks and
   2—Water Tanks.
5. 2—Furnace for Tool Steel and High Speed Steel.
6. Cyanide Pot.
7. Lead Pot.
8. Nitrate Bath.
9. Hoskins High Temperature for melting Ferrous and Non-Ferrous alloys in about 20/lb. lots or small Induction Furnace.
10. Brinell Machine.
11. Olsen Testing Machine.
12. Olsen Tortion Machine.
13. Charpy Impact Test Machine.
14. Tracture Machine.
15. Lathe.
16. Drill Press.
17. Grinder.
18. Polishing Machine.
19. Microscope.

CHAPTER VIII.

MANUFACTURE OF COPPERWIRE AND CABLES

Annual Imports

Articles Imported in 1938-39

Rubber insulated	..	47,69,222
Other insulated wire	..	65,95,494
Telegraph and Telephone	..	98,499
Bare wires	..	17,51,514
Total	..	1,32,14,729

Operations Involved

Rough Annealing:

Coils of Electrolytic Copper 1" to 1¼" dia. and purchased from abroad mostly from Japan. These are first rough annealed in a coal fired furnace. They are heated to about red heat (1150°F) for about one hour and a half and then withdrawn and immediately quenched in water. Quenching not only makes the copper soft but helps to remove scale which comes up during heating in the furnace.

Pickling:

The annealed coils are then pickled by dipping them in dil. sulphuric acid of about 5 per cent concentration for some time.

Cold Drawing:

The drawing of thinner wires from the imported rods is done in successive stages by drawing them through dies of different diameter. Going from one thickness to the next, when the wires get hard they are annealed again, in another annealing furnace near by, the method of annealing being the same as the rough annealing. During cold drawing soap or sud is used as lubricant. For wires up to 10 Gauge steel dies, and from 11-16 chilled dies, and for thinner wires diamond dies are used. When a die becomes useless, it is converted to the next higher diameter. Diamond dies are ground to the next diameter by the help of diamond powder.

Welding:

To join two pieces of wires belt welding is done.

Drier:

To drive out the moisture quickly from coils of the wires, a centrifugal drier has been provided.

Tinning:

All wires which are to be coated with rubber are tinned as chemically treated rubber acts with copper and gets spoiled in a short time.

For tinning the coils are at first pickled in dilute sulphuric acid of 5% concentration, then the wire is drawn through fluxy pads called scrubbers, next through melted tin where they get a coating of tin. The flux used in scrubbers is tallow.

Bunching of Bobbin:

The thin wires are automatically coiled on small wooden bobbins by special machines. All thin wires which are to be stranded must be bobbined.

There are another two machines for bunching cotton thread on bobbins.

Stranding Machine:

There are a number of stranding machines for different sizes of wires.

Rubber Coating:

Raw or smoke rubber mostly from Ceylon or Travancore is purchased and it is thoroughly mixed with chemicals in a pair of rolls. Any colour if required is mixed with the rubber. The chemicals used are kept as trade secrets but sulphur and wax are the two common constituents.

This chemically treated rubber is then rolled into thin sheets in a three high mill and then in another machine the sheet is cut into strips of the required size.

Longitudinal Machine for rubber covering:

Usually 3 layers of rubber are put one over the other on wires. The first layer of rubber is mostly pure rubber without sulphur, the 2nd layer has sulphur and the third has more sulphur. The strips of rubber are pressed on the wire in a machine having a number of grooves, the rubber strips come from top and bottom and the wire is kept in between.

Lapping Machines

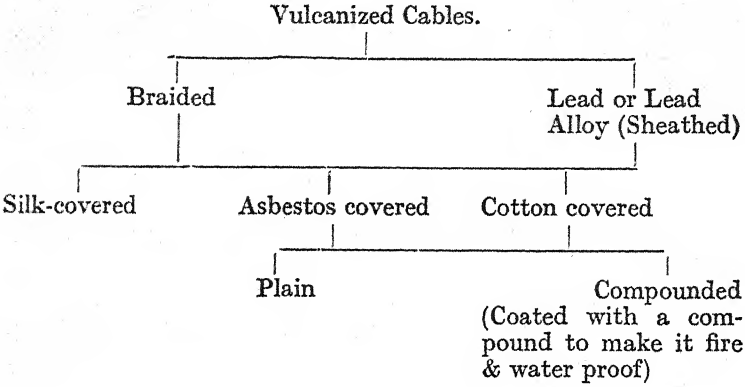
A high speed lapping machine covers the rubber coated wires with a cotton tape.

There is another stranding machine in this section to strand the rubber coated wires, for multi-coloured cables.

Vulcanizing:

The rubber coated wires are wound on drums and then put inside a closed chamber where steam is injected under pressure for about 1 to 1½ hours depending upon the type of insulation used. The maximum temperature of the chamber is about 290°F.

The vulcanized cables are further treated in any of the following ways depending upon use:—



For covering with cotton or silk or asbestos thin thread of these substances are wrapped round the cable. For compounding, the cable is dipped in a solution of compounding materials that are kept trade secrets, but for black cables, pitch is used, for white, zinc oxide and for red, red oxide of lead are used.

For lead sheathing, lead is melted in a furnace and the liquid lead is run into a groove in a 500 ton Davy Press. The lead is forced on to the cable from two sides.

C.A.B. Tyre Sheathed Cables (C.T.S.)

For this type of cables, a thick layer of chemically treated rubber is forced on to a stranded wire in a die and then it is vulcanized.

Cotton & Silk Covered wires:—

Silk or cotton is lapped over wires in special machines of which there are a number. Ordinary flexible wires are also similarly covered, the only difference being that a bunch of very thin wires are used.

Testing Section:

It consists of a small well equipped laboratory to do the following tests:—

Insulation Test:

A piece of the cable is dipped in water for 24 hours and its resistance is found before and after dipping by the help of a potentiometer and galvanometer.

Voltage Test:

There is a transformer which can generate upto 50,000 volts, and cable insulation can be tested up to this voltage.

There is also one small Tensile testing machine and another rapping testing machine for testing the wires if required.

Shipping:

The cables are packed either on wooden drums or in paper bags and shipped to the parties concerned.

List of the Products expected to be Manufactured

1. Rubber insulated Cables.
2. Wires and flexible chords in all grades.
3. Lead and lead alloy sheathed cables.
4. Armoured cables.
5. Cab type sheathed cables.
6. 'Iconite' cables.
7. Ozone proof cables.
8. Varnished Cambric cables.
9. Hard drawn copper conductors—solid and stranded.
10. Annealed copper conductors—plain and tinned.
11. Aluminium and copper-weld conductor.
12. Fuse wires—tinned, copper and lead.
13. Silk, cotton covered and enamelled instrument wire.
14. Pure and vulcanising rubber jointing tape.
15. Hookate tubes—plain and silk covered.
16. Lead pipes.
17. Strip and wires.
18. Trolley wire.
19. Weather proof aerial cables.
20. Wire braids.
21. Tinman's solder.
22. Plumber's metal.

Machinery and Equipment Involved

1. 4 Coal fired Annealing furnaces.
2. A number of boxes for pickling.
3. Ten continuous die machines and a number of steel die blocks.
4. Four tinning machines, each can tin a number of wires at a time.
5. Bobbin bunching machines.
6. 12 diamond polishing machines.
7. 14 streaming machines of various sizes.
8. 4 sets of two high rolls for mixing chemicals to rubber.
9. 2 three high roll set for rolling sheets of rubber.
10. 2 strip cutting machines.
11. 2 longitudinal machines for rubber coating.
12. A set of lapping machines.
13. 4 vulcanizing chambers.
14. 2 Davy Press.
15. A set of braiding machines.
16. 2 machines for making C.T.S. cable.
17. Laboratory equipped with one transformer, two sets of potentiometer with galvanometers etc. Tensile Testing machine, Rapping Machine.

Capital Outlay

Land building and quarters	Rs.	6 lakhs.
Power Station	..	2 „
Equipment and machinery	..	25 „
Working Capital	..	20 „
Total	Rs.	53 „

Weekly production about 500 thousand yards of wire. It is expected to buy all the castings and forgings and even heavy machined parts from the National Workshop.

CHAPTER IX.

MANUFACTURE OF ELECTRICAL MACHINERY

I. Imports of Generators, Motors, Switches, Switch-boards and Control Gears

	1936-37	1937-38	1938-39
	Rs.	Rs.	Rs.
Generators	39,78,088	25,89,569	36,96,763
Motors	35,25,302	46,92,382	63,12,027
Turbo-generator sets ..	15,29,673	8,83,702	37,83,702
Transformers	19,66,052	26,23,071	25,62,716
Switches, Switch boards & control gears ..	48,81,765	54,81,765	90,04,959
Switch boards	3,10,487	4,73,446	5,10,752
	161,91,367	167,43,935	258,70,919

II. Machinery desired to Manufacture

(a) A.C., D.C., Motors and Generators with ratings from 5—400 K.W.
(b) Transformers, ratings from 2 — 300 K.V.A. both single and three phase.
(c) Switches, switch-board and other control apparatus.

III. Materials required

1. Steel plates and sheets having 8 to 4% Si.
2. Cast Iron, Steel and non-ferrous alloy castings or forgings.
3. Brass sheets and rods.
4. Rabbit metal.
5. Solder.
6. Copper wire of different gauges and insulations.
7. Carbon blocks for brushes.
8. Insulating materials, varnish, rubber, cotton, fist paper, fibre boards, ebonite, bakelite.
9. Mica Flakes.
10. Micanite.
11. Slate and marble.
12. Teak wood.

IV. Main Operations in Manufacture

1. Shearing stamping or punching laminations.
2. Plate bending.
3. Core building.
4. Machining.
5. Micanite Manufacture.
6. Coil making.
7. Commutator Building.
8. Winding.
9. Impregnating.
10. Testing.
11. Load Testing.
12. Assembling.
13. Packing.

Other Departments:

(a) General maintenance.
(b) Power, steam and compressed air.

V. Buildings and Layout:

The building is made up of a central bay, spanned by a 15 ton crane. This bay is used for stamping, shearing and other mechanical jobs. Two wings to this central bay, each spanned by 5 ton hand cranes, take care of the other operations except of transformer oil treatment, coil making, micanite manufacture and impregnating.

The latter two operations should be carried out in a brick building separated from the main building to avoid fire hazards. In order to keep the air free from dust and at a correct humidity, it would be necessary to air condition this part of the building. A third building is provided for the heating and reconditioning of the oil for transformers.

For ease in bringing in and shipping materials, a railway track traverses the middle of the main building and connects it with the oil treatment building. Steam and heating facilities are supplied by boiler and gas plant situated on one side of the main building.

VI. Machinery and Equipment Required

1. 1 shear for 1" plates 10'—12' long.
2. 2 shears for sheet steel 6'—8' long.
   4 plate bending machines.
3. 12 die punching machines for laminations.
   4 arc welding machines.
   12 vertical hydraulic presses, two horizontal by-presses.

4. 4 lathes for turning out shafts and commutators.
   4 lathes for bearing.
   4 lathes for making studs for motor cones and commutators.
   2 lathe for pulleys and pinions, couplings, etc.
   2 drilling machines (one big and one small)
   2 planing machines for bed plates.
   2 boring machines to bore bodies and magnets.
   4 boring machines to bore bodies fitted with covers.
   2 machines for making keyways.
   2 electrically heated furnace for white-metal.
5. 2 precipitating towers.
   4 conveyor belts.
   16 tables.
   24 steam heated face plates.
   3 hydraulic presses.
   1 mica milling machine.
6. Various coil making, shaping, insulating machines, mica wrapping machines.
   2 boring mill like machines for making, lifting magnet coils.
7. 3 guillotine shears for mica cutting.
   8 vertical by-presses.
   2 steam heated ovens.
   Commutator grinding machines.
8. 3 Guillotine shears for cutting insulation.
   4 binding lathes.
   80 winding stands.
   8 gas stoves for heating, soldering irons.
9. 2 impregnating chambers.
   2 steam heated chambers.
   1 pressure air pump.
   1 spraying machine.
   1 varnish tank.
10. Various instruments including high potential transformer.
11. Motor generator set, resisters and instruments etc.
12. Various assembling tools for welding, revetting etc.
13. Circular and band saws.

VII. Capital lay out in lakhs of Rupees

Land building and quarters	2
Power and distributing centre	1
Machinery and equipment	15
Working capital	6
	24

Annual Production

8000 Motors and generators and 3500 transformers up to 150 K.W. or 175 H.P. capacity.

It is expected to buy all the castings, forgings and heavy machine parts from the National Workshop.

CHAPTER X.

A BRIEF NOTE ON THE MANUFACTURE OF FERRO-CHROMIUM IN INDIA

The importance of chromium as an alloying element in steel metallurgy is fully recognised and well established. It is not only used by itself but also in conjunction with other alloying elements such as nickel, vanadium and molybdenum. The field of usefulness is therefore very wide and covers a vast range of applications from cast iron alloys, hard steels, automobile steels to high speed steels. Besides the above mentioned uses, the application of chromium is going to expand enormously through the discovery of so called rustless steel and iron.

The chief source of chromium is chromite which occurs in workable quantities in Baluchistan, Mysore and Singhbhum (Bihar). Chromium is indispensable for the production of alloy steels particularly for the automobile manufacture. The manufacture of Ferro-chromium should be taken up in India as soon as possible and indiscriminate export trade which has been allowed in the past must be completely stopped.

Estimate of cost

		Rs.	
1.	Furnace with transformer capacity 6.5 Ton Ferro-Chrome per day.	200,000	Max.
2.	Carbon Blocks lining 30-35 ton (good for 2 or 3 years).	15,000	,,
3.	Building.	50,000	,,
4.	Crane	40,000	,,
5.	Ladles and other equipment	20,000	,,
6.	Miscellaneous	20,000	,,
		Rs. 345,000	
	Working Capital	100,000	
	Total Investment	Rs. 4,45,000	,,
	Ferro-Chrome	Rs. 500/- per ton.	

N.B.—The same furnace can be used for the manufacture of Ferro silicon and calcium carbide with slight modifications.

CHAPTER XI

UTILIZATION OF NATIONAL INDUSTRIES AS A SEAT OF TRAINING FOR INDIAN YOUTH FOR INDUSTRIAL CAREER

1. The following three schools should be started at the Heavy and Light Mechanical Industries as soon as they are fully established.

(i) Trade School for boys between 12 and 18 years of age.

(ii) School for Tool Makers and Electricians. In this school there should be no age limit.

(iii) School for unemployed intelligentsia. Students having qualifications above the Matric standard should be enrolled.

2. **Fundamentals to be observed in the Organisation of Schools.**

(i) The real education of a young man starts when he comes into contact with actual men and materials, that is, when he takes a hammer and an axe and gets out where he can sense life. It is not the book knowledge, degrees or diplomas which count. Knowing a few dates in History, a few equations in Chemistry, a few formulae in Mathematics or a few theories in Economics or Philosophy does not constitute education. It is just like stones. Some can take a beautiful polish while the others cannot. The texture of a man is his courage, vitality, character and his rock bottom brain power. One who has done something for himself and his family counts for one, while one who has done something for his community and the nation counts for more. The greatest and the most educated man is he who has been instrumental in giving bread and butter to the largest number of people. Education which does not enable a man to earn his livelihood is no education at all.

(ii) Useful and dependable men for an Industry cannot be trained in University Class rooms in the company of educated, refined and cultured Professors, but in the operation department of an Industry where one would be required to develop and apply that uncommon faculty that is common sense in dealing with common people and tackling every day common problems of an industrial organisation.

(iii) A purely class room training even along technical lines fails to offer youth much help in a mechanical field; on the other hand a training which includes hand skill does make a person to set intelligently in this world of today.

(iv) Changing conditions in manufacturing methods for mass production, closer limits to measurements and ever increasing importance to the time limit have modified industrial problems to such an extent that the training of youth to most of these modern conditions has become increasingly important and can best be solved within the industry itself. Public Schools and Colleges can and do accomplish this in some degree but there are deep-rooted obstacles which are difficult for the school or college authorities to surmount.

(v) From the very first day in the Shop the boy must feel that he is playing an important and useful part in the scheme of things. He is a producer and not merely a doer of exercises to be thrown to the scrap after the Instructor has accepted them. No explanation of some future benefit to come is necessary. Each task and each day is complete in itself. This constitutes one of the greatest advantages possessed by a school associated with Industry, where useful work within the ability of the boy can be had in quantity.

(vi) It is a part of the educational programme of this school to dignify all necessary work and consequently each boy must be made to take his turn for a few weeks in sweeping floor and polishing windows.

(vii) Students should be paid a minimum scholarship of about eight annas per day. Thus they will develop a confidence in their own ability and a determination to fight for their own security and not rely on the bounty of their family, state or government. They should be taught that the joy from efforts spent in doing things far exceeds any possible pleasure in merely receiving. Thus unconsciously they will acquire a sane outlook on many problems in life.

(viii) The city boy has little in the way of duties that require his physical effort and the education of his muscles is left largely to his sports and to such work as his school may supply. Most boys wish to make things, to fashion materials into useful forms and to give concrete form to their fancies. For all this there is no opportunity in schools. In our efforts to free him from the evil of child labour we have taken from him all obligations for physical duties without which his sense of responsibility remains undeveloped. For without systematic responsibility re-

quiring the use of his muscles directed at first by conscious mental efforts over a period, long enough to develop some dexterity, a boy cannot secure the all round growth which should be his. Higher type of intelligence is required in skilled trades and no stigma is attached to those preparing for it.

(ix) Large industry is a fairly accurate cross section of the community about it. All contrasts of society are there active and indolent, ambitious and unconcerned, careful and careless, skilled and unskilled, the men who accept responsibility and those whose every act must be planned by others. Even now with many unemployed it is difficult to fill positions of trust and responsibility.

(x) There is no job too big to tackle. The student must see everything split up to a single unit. This being done the job is within the comprehension of the student. He must realise that it is so with everything in life. Every task that is within the power of man to do must first be split up into its simple parts, after which the unit must be reassembled into the completed whole. Every job which is properly done involves disassembly and then finally assembly. This is one of the greatest educational lessons in all teaching and nowhere outside the shopwork is it so easily illustrated, and carried out.

(xi) For more than 20 years the Ford Motor Co., has maintained a school system based upon the above mentioned basic principles to train men not only in physical and mental skill but also in those attributes so essential for leadership. At present a considerable number of graduates are holding responsible positions in the Ford Plant as well as elsewhere and have successfully replaced old type of Mistries and Supervisors, the so called practical men having decided contempt for everything scientific.

3. Trade School

Boys should be enrolled between the ages of 12 and 15. They should graduate at 18 or 19 and offered jobs in the Heavy and Light Mechanical Industries. They should, however, be under no contract or obligation to accept them. Their work with the Trade School should be considered ended and they should be free to seek work wherever they wish.

The Trade School should operate on co-operative basis. It has an advantage in controlling the shop work as well as the class work. Thus it will offer unique opportunity to develop a work sense which is of great value to a student in his business life.

Until the academic course is completed one week should be spent in class work. This is followed by 2 weeks of shop work. Under this arrangement there are 14 weeks of class work, 34 weeks of shop work and 4 weeks of vacation per year.

During all these periods the student should be paid a cash scholarship. This rate should be adjusted 7 times a year according to his progress. He may receive as much as Re. 1/- per day, while he is still attending class work. When he has completed class work, and all his time is spent in the shop, the maximum scholarship can become Rs. 1/12/- per day.

In order to make it possible for each boy to maintain a saving account, the School should give him extra two rupees each month. This must be deposited in some Bank and kept there as long as he is a member of the school. **If possible, the boys should also be given a free hot lunch at noon.**

To justify this expense all the shopwork must be productive. With boys in all stages of their training a great variety of work is needed. Young and inexperienced students should be assigned the task of salvaging small tools. In this work they will acquire a great deal of hand skill and, as a bye-product, will obtain a knowledge of tools and their uses and a respect for their proper handling. Thousands of screw-drivers, wrenches, hammers, oil cans, shears, and hacksaw frames can be thus repaired.

The older boys should be engaged in the manufacture of tools, cutters, reamers, drills, arbors, and special tools that is, anything that any good tool-room might be called upon to produce.

One man should be given the task of routing the boys through the shop so that they may have as varied an experience as possible in many of its departments.

Boys, who are adapted to tool-making should have received, before they graduate, the following machine training:—

Shaper	3 months
Lathe	4 months
Miller	5 months
Grinder	5 months

It is evident that boys, who graduate at 18 with this experience are well on their way to become machanics.

Academic training should be closely correlated with the shopwork. During the 4 years devoted to classwork,

Mathematics, Shop theory and Drawing should come daily. In addition to this the course of study should include Civics, Economics, Mathematics, Physics, General Chemistry, Quantitative and Qualitative Analysis and Metallography.

Although the scholarships amount to a considerable sum the School can be made nearly self-sustaining. And measured merely from the selfish motive the net expense will be small when one considers the trained workers available for the Indian Industries.

4. School for Tool-Makers and Electricians.

In this School there is no age limit. All apprentices must take the class work it offers. However, it must be emphasised that class work should also be open to all the employees of Light and Heavy Mechanical Industries, including graduates of the Trade School, but only apprentices should receive shop instructions. There should be no charge for tuition but a student must attend classes on his own time either before or after his day's work. To make this possible subjects should be taught at four periods during the day.

Theoretical work should be given twice a week over a period of 3 years and should consist of drawing, mathematics and important aspects of mechanical and electrical engineering. About 20 men may be required for teaching the academic subjects and keeping the records and a few men to devote their time to shop instructions and supervisions.

The following organisation of class work has proved quite satisfactory. At the Ford Motor Co., Detroit, seven lessons are given in a subject and then followed by a written examination. If the student has a passing grade of 70 he enters the next series of seven lessons. If he fails it is necessary to repeat only the 7 lessons. This plan has prevented many students from getting discharged.

Before the shop training is considered complete the student should have a minimum of 6 months on the shaper, 8 months on the lathe, 9 months on the mill, 8 months on the Grinder and 9 months on the bench. Even this schedule should be subject to considerable variation, depending on the skill of the student. In every case, the shop instructor should primarily be the one to determine which part of the training may be shortened and which extended.

The regular work coming to a department during a period of 6 months will ordinarily furnish sufficient variety to give a student enough experience to consider his training finished in that department.

When a student has completed his course he should be given a card stating the experience he has had which should entitle him to be considered a journeyman. From this time he should be placed wherever he is considered to be most valuable.

Electrical apprentices would be treated in a different manner as in most cases an electrician must go to the job while the job usually comes to the tool-maker.

An electrical journeyman should take with him an apprentice assigned by a shop instructor, and should explain to him the safe and correct methods of installation and maintenance work. No apprentice should be kept long with one journeyman. The shop instructor should change him frequently so as to broaden his viewpoint by giving him a chance to observe the technique of different journeymen. This shall serve as an incentive for him to improve his own methods.

5. School for Unemployed Intelligentsia

Employment office statistics, taken from any modern industrial concern, clearly show that there is a far greater demand for skilled workers than for Engineers. It is an irony of fate that so far the country has spent more time, money and energy in the production of University trained Engineers rather than for skilled and loyal workmen—the real living force of a successful industry.

At present there is practically no provision in the country where unemployed intelligentsia can get even a rudimentary practical experience in an Industry in order to entitle him to apply for the job of a skilled worker. No employer can afford to be so generous as to employ untrained young men in place of skilled workers. Under these conditions, in order to make two ends meet, Matriculates or even ordinary Arts or Science Graduates have to join an industry in the capacity of low paid clerks, khalasies, or even as coolies.

In order to relieve unemployment among the educated young men it is absolutely necessary to give them some trade to enable them to find employment more easily. It is suggested that a training course of 6 months' duration should be offered to the apprentices in Machine Shop, Foundry, Brick work, Electrical and Mechanical Repair, Heat Treatment or Welding. Only students having qualifications above the Matric Standard should be enrolled. The primary object is to give boys, who are looking for employ-

ment in Industries work, opportunity for a brief training to get a start in life.

In all the 3 schools, first emphasis should be laid on safety. At the time of enrolment the boy should be given a talk on safety and a printed sheet of instructions. As he enters each department in the shop an instructor should question him on general safety precautions and give him printed instructions on safe practices in that type of work. This shall make the student safety-minded and very few accidents would occur.

Orderliness is the second great lesson a student must learn. The premises must be kept clean and his work and tools always properly placed. Confusion and litter have no place in modern industry.

The third ideal stressed should be accuracy. But this alone is not enough. While greater accuracy is ever demanded, the time required to accomplish it must be watched. To train a boy to do accurate work without bringing in the time element would leave him with no hope of employment under the rigid demands and keen competition of to-day.

Text books containing suitable material for use in these Schools will be difficult to find. Lesson sheets in different subjects shall be compiled by the instructors. These will be valuable not only in the above schools, but also in other trade schools in India.

CHAPTER XII.

GOVERNMENT AID, THE MOST ESSENTIAL PRE-REQUISITE FOR THE SUCCESSFUL ESTABLISHMENT OF NATIONAL INDUSTRIES

(a) The urgency of the revision of the Government of India Act, 1935

A national plan without a national Government is a contradiction in terms. The part which the State has to play in the industrialisation of the country is of very vital importance.

In Germany, towards the latter part of the 19th Century when the industries were young and new, the State not only gave bounties and subsidies to the establishment of industries, but actually started numerous new industrial units. Since the Great War, both the Federal and the Local Governments in Germany have greatly assisted in the development of power. In addition, the State has assisted the heavy industries in the shape of giving direct help to large manufacturing firms and purchasing large blocks of shares in a number of small ones.

In Japan, where people lacked industrial initiative in the beginning, as they do to-day in India, the State followed the same principles as in Germany. It not only gave bounties and subsidies to large scale industries and assisted small cottage industries through the various co-operative societies but also set up Iron and Steel works, Textile Mills, Railways and Ship-yards of no mean magnitude. It also established the Bank of Japan and other Industrial Banks in order to facilitate the extension of credit.

In France, the State undertook the financing of the Coal Industry and of the reconstruction of Iron and Steel works. It also played an important part in the development of Hydro-Electric power. Numerous industrial co-operative societies were set up by the State all over the country to supply short term credit facilities to small manufacturers.

In England, State aid has been given to both the old and new industries. In 1920, the Government floated the Home Grown Sugar Limited and undertook to purchase the same number of shares as were allotted to the public

up to a maximum of 250,000 shares of £1 each. In addition, the Government guaranteed interest at 5 per cent for 10 years on public shares and gave an undertaking that it would not take any interest on its own shares until the public subscribers had received 5 per cent. Recently, England has utilised tariffs as an instrument of international bargaining and of international equilibrium and this has been successful in reviving some of their important industries like Iron and Steel.

In India, too, it is being recognised that through the grant of protection, subsidies and bounties to deserving industries and proper regulation of buying facilities, Railway freights and Fiscal Policies, the Government, if it so desires, can assist in a substantial measure the industrial development of the country. However, in the Government of India Act of 1935 there are certain provisions relating to commercial discrimination.

Section 12 of the Act makes the safeguarding of the financial stability and credit of the Federal Government a special responsibility of the Governor-General and gives the latter powers to interfere with and over-ride the policy of its Ministers.

Section 34 provides that no demand for a grant shall be made except on the recommendation of the Governor-General and makes certain items of expenditure chargeable to the Revenue of the Federal Government without being submitted to the vote of the Legislature. The items of expenditure thus charged absorb over 90 per cent of the Federal Revenues and are beyond the Legislature's purview; and considering the further powers that are vested in the Governor-General under Section 35 relating to the authentication of Schedule of authorised expenditure and under Section 36 regarding supplementary demands, the Legislature, may be said to have little control over the Revenues of the Federal Government.

Chapter III of Part V, particularly Sections 111 to 116 thereof, lays down extraordinary restrictions preventing the Federal Government from adopting any measures likely to affect British vested interests, even if the latter are contrary to the interests of India. The initiative for all discriminatory legislation is left to His Majesty's Government in the United Kingdom, instead of to the Federal Legislature; and British nationals are guaranteed free entry and domicile and exemption from any administrative or legislative restriction, so that while they enjoy the same

civic rights as Indian nationals, the burdens of citizenship they have to bear are much lighter.

The principle of reciprocity to which reference is made under Sections 111 to 116 does not seem to be of much practical value to India. The number of Indian concerns operating at present in the United Kingdom is very small as compared with that of the British concerns operating in India.

Further, the general preclusion of the Federal or Provincial Governments from granting to any national enterprise exemption or preferential treatment in respect of taxation, seems to be an undesirable feature of the Act. The question of investing the Indian Federal and Provincial Governments with the same powers as are possessed by Governments of foreign countries, to accord preferential treatment to any of the key industries under certain conditions should be considered at an early date.

Also, Section 115, which accords special treatment to snips and aircrafts registered in the United Kingdom and denies to the Indian Government the power to discriminate between ships and aircrafts registered or owned or controlled in India and those in the United Kingdom makes it difficult for the Indian Government to reserve its coastal trade for its own nationals and help in the development of indigenous shipping industry.

Sections 111 to 116 relating to the grant of subsidies or bounties appear to be detrimental to Indian interests. They provide that the Companies incorporated in the United Kingdom and carrying on business in India would be eligible for the grant of any bounties or subsidies payable out of Indian Revenue in the same way as companies incorporated in British India. This would mean that protective tariff or a bounty would not be really effective in the case of industries faced with competition from the United Kingdom.

Further the definition of the function of the Governor General in relation to the Reserve Bank of India embodied in Sections 152 and 153 of the Act not only gives him the usual power to veto, but also precludes the Federal Legislature and the Federal Minister from initiating any legislation regarding currency and coinage without the previous sanction of the Governor General in his discretion.

Sections 181 to 189 deal with the Administration of the State Railways by creating the Federal Railway Authority and Part VIII of the Act gives such wide powers to this Authority that it will work like an independent State

within a State entirely uncontrolled by the Federal Legislature. Considering the importance of Railway transport to industries and trades in general, it seems desirable that the Railway authorities be brought under the direct control of the Federal Legislature. Also, the provisions of the Act relating to control of external affairs vest this control in the Governor-General.

The above mentioned Sections should be considered for revision as it is difficult for any country to develop her industrial potentialities without adequate control over its currency, coinage, tariff, shipping, finance etc.

(b) Financial Help in the Initial Stages of Industrial Development

Money is the sinews of industry and the whole problem of our industrial expansion centres round the question how sufficient funds can be raised to start the proposed industries. Lack of financial facilities is the rock on which most of the indigenous industries are finally wrecked. This does not mean that India has no capital. That the capital resources of India are not so meagre, can very well be proved by the extent of her contributions to Government loans. Shares of Reserve Bank were sold in India more quickly than anybody expected. Giltedged shares and debentures have a ready market in Indian Stock Exchange. India therefore, cannot be said to be in want of sufficient finance to start a couple of basic industries, nor is Indian capital really so shy as is usually represented in text books. The real reason of the apparent immobility of Indian capital is that our business promoters hardly enjoy the confidence of the public. Indians usually are not industrially minded and they have, besides that, been more than once robbed of their money by industrial gamblers. So many Indian industrial enterprises have ended in failure, that people have grown suspicious of any industrial undertaking organised by private enterprise. We cannot blame private investors for the distrust they entertain against business organisers. Men who finance, go to the best money market and buy with expert foresight. The chances to secure money depends solely upon confidence that can be inspired in the capitalist.

Failing this natural source of money supply, we have no other alternative but to fall back upon the patronage of the State. But here also, we can hardly expect the State to furnish all the funds necessary for the purpose. Key industries require enormous capital resources, the burden

of which is too heavy to be borne by the State. Provincial Governments are handicapped not only by their limited sources, but also by many statutory disabilities.

In order to lay all plans of industrial development on a sound financial basis, it seems necessary that both the State and the people should be brought to share the responsibilities of financing the industries.

The most practical method seems to be to invite the great and powerful industrial magnates of this country to take up particular initiative for which they are best qualified. Government aid should be extended to them just in the same way as the Railways were patronised by the State in the early days of their establishment in India. Reliable and reputed firms of astute businessmen should be allowed to organise and run the industry. The Government should guarantee a certain percentage of interest on the capital subscribed for a limited period. If the Government comes forward in this manner to take some risks, it will create confidence, and plenty of money would be forthcoming. A Joint Stock Company organised on this basis will be in no want of funds, and if efficiently managed, there is nothing to hinder it from becoming a success. Just as the State-owned Company-managed Railways are organised by private firms but are always controlled and supervised by the Government, the proposed industrial enterprises also should be left to be managed by private companies under the strict surveillance of the State.

In emphasising its recommendation for the adoption of the financial scheme given above, the Committee would like to point out that the money spent on the interest would be no loss to the State, but on the contrary, it will be one of the most fruitful sources of increased revenue. By guaranteeing 3% interest for 10 years on the invested capital of 6½ crores of rupees all the Provincial Governments jointly will have to guarantee 20 lakhs of rupees per year in the form of interest. This money will be fully repaid when the enterprise becomes a flourishing industry, capable of yielding profits to the State practically for ever.

The above is only a tentative outline of the scheme which should be discussed with financial experts before it can be finally adopted.

State aid has been of vital importance in the industrialisation of all countries. In India also, considering the lack of banking facilities and the general lack of industrial initiative amongst the public, a substantial measure of state

assistance is essential before real industrial development can take place.

It is true that this necessity has been recognised to some extent and the Central Government has asssisted several industries by means of tariffs, subsidies, bounties or loans, and acts have been passed in various provinces providing for assistance in various forms by the Provincial Governments to industries. But the State will have to render financial assistance to industries on a much bigger scale than hithertofore, if industrialisation of the country is really meant.

(c) Industrial Labour Council

Industrial backwardness of India is to a considerable extent due to the inefficiency of Indian labour. Though India possesses enormous man-power, and though Indians are inferior to none in intelligence and craftsmanship, India nevertheless is sadly lacking in the supply of skilled labour, the real living force of a successful industry. The deplorable inefficiency of Indian labour is mainly due to lack of proper education and technical training. Indian labour is mostly composed of illiterate and ignorant men and women who had never been trained for the work they are required to do.

In recruiting the labour force, the idea of the average employer seems to be that any man is good enough for working in a factory. This is obviously a very wrong principle. Indiscriminate recruitment of labour may prove ruinous to the industrial development of the country. The creation of a competent, responsible, intelligent and technically skilled labour force is the first essential for the growth and success of industries in this country. Uneducated labour is as bad as or worse than an undisciplined army, and India can never hope to fight her industrial battle successfully against the progressive nations of the world with her ignorant host of unskilled and unintelligent workmen.

In recent years, labour has come into the lime light in India, more of course as a political power than as a factor of industry. Though there is no end of talk about the betterment of labour conditions, very little has been said and done for the improvement of the efficiency and skill of the labourers. Skilled and disciplined labour is a national asset but unfortunately this aspect of the question is being completely ignored in India at present. It is time for those, who are actively engaged in ameliorating the labour con-

ditions in India, to understand clearly that the greatest benefit that can be conferred upon the labourers is to make them better workmen by increasing their skill and efficiency.

The National Workshop should be an institution where workmen should be properly trained and educated so that they would be able to realise their duties and responsibilities towards quality and quantity production at low cost. They should be made to feel that their contributions to the growth and development of industry is not in any way less important than that of capital or management. In this way a skilled and intelligent labour-force should be created in these national industrial concerns, and the trained and disciplined workmen should be the nucleus for further groups of responsible and loyal workmen, proud of making all industrial undertakings a success.

In order to create such intelligent labour, it is necessary that recruitment of labour should be carried on with discrimination. In the army and navy only those who possess certain qualifications are taken as cadets. In recruting labour also, there should be some standard to which they should conform to be selected as a workman, and general intelligence and technical aptitude of a man should always be taken into consideration.

The attitude of the Government should be strictly impartial in all cases of labour troubles and disputes; while the legitimate grievances of workers must be removed, care should also be taken that the industry concerned does not suffer from lack of patronage. The State should look to the interests of labour and capital with an impartial eye and should also exercise its influence in bringing about a reconciliation between the two contending factors.

The establishment of a National Industrial Council representative of both industrialists and labour is the most sensible solution for the stoppage of sit-down and lightning strikes which at present are of frequent occurrence. According to Mr. Harold Butler the conditions of employment in large scale factories though capable of further improvement are in reasonable correspondence with India's present stage of industrial development and the pace of reform in different provinces should be such as would ameliorate the social and economic conditions of labour without at the same time causing any misgivings in the minds of the industrialists.

(d) Transportation and Distribution

India is a very vast country. The transportation of raw materials and distribution of finished articles throughout the length and breadth of the country, is a very complicated affair.

The two main methods of transportation are the Railways and the Steamers. The administration of the former is in the hands of the Central Government which is not yet National, and the latter is almost entirely owned and managed by foreigners.

According to the India Act, the administration of the Railways is transferred to a statutory body separate from the Federal Assembly. There is an inherent defect in the constitution of the statutory body, which is composed of men, who do not sufficiently care for the development of the Indian industries. If we go to the early history of the establishment of the Railways in India, it will be abundantly clear that Indian Railways are not a commercial proposition, nor were they established for the exclusive benefit of the Indian people. The original purpose of Indian Railways was more a strategic necessity than anything else.

As regards the shipping companies, they are very unwilling to make any sacrifice for the benefit of Indian industries. Apart from the question of overseas trade, the popular demand for the reservation of coastal traffic for the Indian owned and Indian managed shipping companies, has been always neglected by the Government. This question has been raised year after year in the Central Legislative Assembly by the popular representatives of that body but it has never received any effective response or support.

Without the active co-operation and assistance of these transportation agencies, it is almost impossible to keep down the prices on a favourable level in comparison with imported articles. Many instances can be cited to show that the transporation of materials from America, Europe or Japan costs less than the transportation of goods from one Indian port to another. On the other hand, the industrially developed countries like Japan, Germany etc., are paying bounties to the shipping companies for the transportation of goods to other countries at a very low rate.

Besides high freight charges, there are other disadvantages, which have been imposed upon the people by the transporting agencies. Cost of bulky packings are insisted on for the purpose of avoiding the damages that may be caused in transit. Proper care in handling the packages is never taken, not even when it is specially asked for.

There is very little provision for refrigerated wagons and godowns for perishable articles. In short, these transportation agencies are not sympathetically co-operating with the trade and industry of the country. If the facilities of transportation that are quite common in other countries, are not extended to the commercial people of this country, it will be extremely difficult for Indian manufacturers to compete against foreign producers.

Cheap and efficient transport facilities, carefully co-ordinated, are two of the major conditions for industrial development. In India, however, such facilities lack proper co-ordination and are inadequate to the needs of the country. What is required is a CENTRAL BOARD OF COMMUNICATIONS with a substructure of provincial transport boards, to study the transport requirements of the country, draw up a programme of future transport development on a carefully co-ordinated basis, and devise ways and means of financing it. Road mileage in India should be increased, difficulties of inter-provincial transport removed, and automobile industry, as recommended in the Report should be started, so that India may have her own supply of motor vehicles and allied machinery.

As regards railways, the Federal Authority created under the Government of India Act 1935, should be brought under the control of the Federal Legislature, and freight policy determined with a view to the industrial needs of the country. Facilities for training in mechanical, electrical, railway and marine engineering should be provided on an adequate scale in India, and the manufacture of machinery and materials required for Indian railways taken up in workshops built up in India, so that the country may not have to depend on foreign countries for her railway requirements.

Concessions should be available for the first 5 years at least in regard to Railway freight for raw materials and finished products.

As regards shipping, steps should be taken to reserve at least a portion of India's coastal trade for her own nationals, and train captains and marine engineers. An ALL-INDIA SHIPPING BOARD should be set up to evolve a scheme for the future development of indigenous shipping and protection given to this industry against foreign vested interests.

Also, the Aviation Department of the Government should, by suitable propaganda, popularise air transport, provide facilities for training and research in aircraft, and

construct suitable landing ground for aeroplanes in all important centres.

Finally more use should be made of postal, telegraphic and telephonic facilities to communicate messages of business importance from one centre to another.

(e) Administration

The responsibilities of an administrative management may be listed: to establish sound business policies, to finance the enterprise, to control the expenditure of funds, to develop an organisation whose functions are logically assigned to competent individuals, to design, test, improve, and warrant a product which is to be distributed according to demand and competition, to build or secure plant and equipment and utilise them economically and effectively, to produce adequate supplies of proper raw materials to maintain a suitable supply of labour and supervise and coordinate its effect, to organise and sustain proper relationships between owners and workers, to formulate procedure based upon practicable and economical methods and to manufacture and sell at a profit. Such administrative staff can be had only from a class of people who have been devoting all their efforts in studying scientifically economics of business from the time they have realised the responsibility of life. The Committee thus holds the opinion that the organisation of the manufacturing units recommended be entrusted in the hands of such selected people who have already shown their capability in efficient management of big industrial concerns. For proper and efficient administration we should take the State owned but company managed Railways as the rough prototype, in which the actual management lies in the hands of some well-organised and reliable firm, under strict supervision from the Government. Experienced industrialists should have the control over the management of the industry, but Government should have proper control over the administration by means of sending some nominated members to the Board of Directors and also by auditing the accounts of the Company every year.

Considering the existence of a large number of trained engineers, chemists, metallurgists and other specialists, of whom some have been trained in Foreign Universities or with foreign firms, it is reasonable to hope that with the progress of industrialisation and the acquisition of further industrial experience, India will eventually possess a sufficiency of efficient managers and superintendents to operate

her industries, especially when technical and commercial education has been given a place of prominence in the curricula of the Indian Universities.

In the beginning it would be necessary to recruit covenented hands (Experts) from abroad. They should be engaged as consultants and not as superintendents or supervisors. They should be called on contract basis on a reasonable monthly salary plus a lump sum bonus to be given at the termination of their services provided they have trained up Indian assistants under them.

(f) Sales Organisation

Selling and marketing of manufactured goods is nowadays an international problem. In other countries, the Government is undertaking the work of distributing the manufactured articles of one country to other countries, through the help of various trade agreements, which often help to secure the raw materials in exchange of their manufactured goods. Unfortunately for this country, Indian trade agreements are concluded sometimes against the very wishes of the people and we are forced to sell our raw materials to foreign nations in exchange of finished goods. Unless this is stopped and manufactured goods are purchased only in exchange of manufactured goods, the surplus raw materials being sold to other countries on cash payment we can never hope to place our manufactured goods on the same footing with the manufactured goods of other countries in the world market.

In internal marketing too, the producers have to suffer from many serious difficulties. According to the method usually adopted, Indian manufacturers supply goods on consignment basis, without any due date of payment, while in case of foreign consignments, the same distributor does not hesitate to pay in advance or within a fixed date. Consequently it is quite natural for the distributor to press the sale of imported articles with greater zeal and neglect the articles manufactured in India.

Also almost all the major industrial countries of the world have realised the value of advertisement and publicity in extending the sale of their goods both at home and abroad. Not only has each important manufacturing concern set up a special department with an army of salesmen to tour the different markets but has instituted market research, the object of which is to study continuously the trend of consumers' preferences and prejudices and the possibility of exploring new markets or increasing sale

in established markets, and to work out methods for the expansion of business in general.

One of the lessons learnt from the various business establishments and statistical researches of recent years is that the process of taking goods from manufacturers to consumers is extremely costly. The spread between the price received by the prime producer and that paid by the consumer is astonishingly large, and the part played by middlemen in the ultimate disposal of goods has consequently assumed an importance in India which is neither just nor necessary. The extreme difficulty experienced by Indian manufacturers in selling their goods in proper markets is a great setback to Indian Industrialism.

Owing to an almost complete absence of marketing facilities, Indian producers are compelled to run into the clutches of profiteering middlemen who not only rob the producer of his just dues, but also exact unusual high prices from consumers whenever possible.

The Committee recommends that a sales organisation should be set up by the Government to take charge of proper, quick and easy distribution of products throughout the country. Designs and prices should as far as possible be standardised, and numerous distributing centres should be set up throughout the length and breadth of the country to cater to the needs of the people even in the innermost villages. In organising the sale, we can learn our lesson from Messrs. Bata, and the Burma Oil Company. They have their selling centres in all important towns, and the prices are the same throughout. Similar organisations should be set up by the Government, or the existing co-operative organisation centres may be utilised for the purpose.

(g) Internal Competition

Internal competition has become a great hindrance to the growth of industry in this country. Apart from the war of rate-cutting between the various indigenous firms, the problem of internal competition has become further complicated by the large number of foreign concerns established in India. Reference may be made in this connection, to the findings of the External Capital Committee's Report, where it is recommended that foreign capital should be allowed to be invested here without any reservation. The National Planning Committee must not overlook the obvious ruinous effects of such uncontrolled importation of foreign capital into India. Increasing investment of out-

side capital is the indirect result of the protective tariff maintained by the Government, because foreign firms have found it very profitable to establish their branch organisations in this country, instead of exporting their finished products. These branch organisations of foreign firms have become a real menace to the indigenous industries. If the foreign manufacturing concerns, who are highly equipped with technical knowledge and experience, and are backed by enormous financial strength, are allowed to come here and establish themselves in competition against indigenous firms, Indian industries will be simply wiped out of existence. According to the existing law of the country, it is not possible to check this inroad of foreign capitalists into India either from the British Empire or from any other favoured nation.

The list given in the pamphlet, entitled "Swadeshi—True and False" by Mahatma Gandhi and others, issued by the Harijan Office, Poona, will show that quite a large number of foreign firms established in this country, are keenly competing against Indian manufacturers, whom the Government of this country is powerless to protect. If this present influx of foreign companies is not properly controlled, it will be extremely risky to take up at present any big industrial venture like the manufacture of Motor Cars, standardise the articles required for the Indian Railways, Locomotives etc. The seriousness of this danger can, however, be to a certain extent mitigated by removing the existing protective duties. The giving of State aid to deserving industries directly in the shape of bounties or loans should be seriously considered.

(h) Standardisation of Designs

Standardisation of designs is absolutely necessary for the mass production of commodities. Though it is a very important question, still, no attempt has so far been made to standardise the quality and types of our manufactured goods. The Railway Board have very recently started to standardise the articles required for the Indian Railways. The Indian Stores Department is also trying to standardise the articles required by the Government. These attempts at standardisation, however, serve no useful purpose, because specifications have been worked out by Government Departments without any knowledge of the problems confronting the Indian manufacturers. Though named and styled as Indian Railway Standard or Indian Stores Department Standard, it is more or less a copy of British Standard.

Absence of Scientific Standards has done great harm to our medical and chemical industries, because unstandardised articles of inferior quality are being imported into this country without any restriction and are competing dangerously with our indigenous articles. It is therefore, absolutely necessary that in order to ensure efficient production, Indian Standards should be set up for all classes of articles before any kind of industrial planning is seriously taken up.

(i) Investigation into the High Prices of Indian Manufactured Articles

Prices of indigenous articles are always higher than those of imported goods, and it is essentially necessary that the causes of this strange economic phenomenon should be thoroughly investigated. If it is presumed that our cost of production is high, no time should be lost to find out why it is so, and a searching enquiry should be instituted to ascertain the present condition of the existing Indian Industries.

All industries should be subjected to the following short questionnaire:—

(a) Whether the existing industries are actually producing wealth for the nation or not.

(b) Whether these industries are actually improving the economic condition of the people or whether it is taxing the people for the benefit of the shareholders and the workers.

(c) Whether the industry is enjoying protection and if so, why?

(d) Is the high cost of production due to the inefficiency of (a) Administration, (b) Technicians and Scientists, (c) Labour, or (d) Machinery and Equipment?

(e) Whether our industries are receiving the same fostering care and patronage from the State, as is found in other countries.

(f) Whether there is any inherent defect or disadvantage in Indian climate, which is retarding the progress of our industries.

REFERENCES

1. Gandhi and others	—	Swadeshi—True and False.
2. Sir M. Visvesvaraya	—	Proposals for an Automobile Factory in India.
3. J. J. Ghandy, General Manager, Tata Iron & Steel Co., Jamshedpur	—	Memorandum on the Industrial development of India.
4. Dr. Syed Mahmud	—	A Plan of Provincial Reconstruction.
5. J. J. Ghandy, B. Sen, P. N. Mathur.	—	Joint Memorandum as Members of Mining and Metallurgical Sub-Committee of the National Planning Committee on Mineral Resources of India.
6. Prof. K. T. Shah.	—	Abstract of proceedings and other particulars relating to the National Planning Committee.
7. P. N. Mathur.	—	Personal notes when employed as Metallurgical Engineer, Research Department, Ford Motor Co., Detroit, U.S.A.
	—	Paper read at the Rotary Club, Jamshedpur on the training of youth for Industrial career at the Ford Motor Co., Detroit, U.S.A.
8. C. L. Anand.	—	The Government of India Act, 1935.
9. Thomas.	—	Register of American Manufacturers.
10. P. N. Mathur	—	Report of the Mechanical Industries Committee, Bihar.
11.	—	India's Sea Borne Trade 1936-37.
12.	—	Industry Year Book & Directory.

APPENDIX I.

AVAILABILITY OF THE BASIC RAW MATERIALS REQUIRED FOR ESTABLISHMENT OF ENGINEERING AND TRANSPORT INDUSTRIES IN INDIA

1. Coal.

Coal tops the list as the most important mineral of India. As producer of coal in the British Commonwealth, India comes second to the United Kingdom and ranks ninth in the world. Coal output during 1936 was a little over 22,500,000 tons. Valued at nearly Rs. 6½ crores (£4,700,000). There was a decrease of 13 pies per ton in the pit's mouth value of coal for India as a whole, from Rs. 2-13-4 in 1935 to Rs. 2-12-3 in 1936.

The Jharia coal field accounted for 39.05 per cent of India's production, the Raniganj coal field 32.51 per cent, Morkara 6.27 per cent. French Valley 5.57 per cent., Giridih 5.09 per cent, and the other fields less than 3 per cent. each.

World coal output in 1936 amounted to 1,425 million tons as compared with 1,300 million tons in 1935. Of this the British Empire produced 297 million tons in 1936, and foreign countries 1,120 million tons. Britain heads the list in Europe with 221,928,387 tons of Bituminous coal. Germany came next with 155,878,404 tons of Bituminous coal and 159,148,475 tons of Brown coal. Russia follows with 120,896,800 tons.

The United States of America is the greatest coal-producing country in the World. In 1936 the output amounted to 387,563,000 tons of Bituminous and Lignite coal and 48,893,000 tons of Anthracite coal.

Of the Empire Countries, Indian output is important next only to that of Great Britain. In 1936, she produced 23,212,457 tons as against 22,607,582 tons in 1935. South Africa comes next with 14,607,813 tons and Australia with 11,370,409 tons.

Of the Foreign Countries, the more important producers are Belgium (27,432,982 tons), Czechoslovakia (27,736,753 tons), France (44,512,354 tons), Poland (29,278,040 tons), and Japan (37,466,000 tons).

The statement given below shows the output of coal in the various provinces in British India during the years 1935 and 1936:—

	1936	1935
Assam ..	2,01,593	2,18,830
Baluchistan ..	3,451	4,946
Bengal ..	66,67,841	66,82,752
Bihar ..	1,20,15,205	1,24,09,497
C. P. ..	15,07,982	15,26,690
Orissa ..	31,061	27,331
Punjab ..	1,56,849	1,44,423
Total ..	2,05,83,982	2,10,14,469

The figures of output for the principal coalfields are as follows:—

Coal Fields.	1936	1935
Jharia ..	8,830,144	9,245,292
Raniganj ..	7,305,437	7,348,223
Bokara ..	1,417,227	1,331,272
Giridih ..	698,133	708,789
Karanpura ..	396,083	424,536
French Valley ..	1,259,133	1,214,099
Assam. ..	201,593	218,830

The total imports of coal in 1936-37 were the highest for the last three years at 74,923 tons valued at Rs. 11,31,665 as comparred with 59,437 tons valued at Rs. 9,49,124 in 1935-36 and 56,754 tons valued at Rs. 9,17,302 in 1934-35.

Exports of coal during 1936-37, were 249,826 tons, valued at Rs. 20,17,918, which compares with 183,025 tons, valued at Rs. 28,78,683 in 1934-35. Thus it will be seen that though the 1936-37 figures mark an improvement over the previous year, they are still below those for 1934-35.

The following figures giving the average value per ton of coal put into wagons in various districts may be of interest—

	Rs.	as.	p.
Assam	8	6	5
Baluchistan	5	14	5
Bengal	2	10	8
Bihar (Jharia coalfield)	3	2	4
Central Provinces	3	2	4
Punjab	3	14	8

There were increases in the average value per ton of coal in Bengal, Bihar and the Central Provinces, of annas 1-4, annas 10-4 and annas 10-3 respectively. In the other provinces there were decreases.

The average number of persons daily employed in the coalfields during the year was nearly 162,000.

2. Petroleum

Although petroleum is the second in importance of India's Minerals, India produced only .64 per cent* of the world's output, her place on the world's list of oil producing countries being thirteenth. Of the total production of nearly 335,000,000 gallons about 65,000,000 gallons come from Assam; 4.4 million gallons approximately from the Attock District in the Punjab, and the remainder from Burma. Over 196,000,000 gallons of kerosene and fuel oils were imported.

3. Iron Ore

As in the case of coal, India is the second largest producer of iron-ore in the British Empire, and ninth in the world. India's output is however, completely dwarfed by the production in the United States and France but her reserves of ore are not much less than three-quarters of the estimated total in the United States, and there is every hope that India will eventually take a much more important place among the world's producers of iron ore. The production of iron ore during the year was over 26,000,000 tons valued at nearly Rs. 40 lakhs (over £300,000). The mines are mainly in Singhbhum, Bihar, and Keongjhar and Mayurbhanj States.

At the present time Iron Ore is being produced on a fairly large scale by three companies namely:—

(1) The Tata Iron & Steel Co. Ltd.
(2) Messrs. Bird & Company.
(3) The Indian Iron and Steel Co.

Messrs. Tata Iron and Steel Co. and the Indian Iron and Steel Co. produce iron ore for their own consumption, namely for the manufacture of Pig Iron and Steel; but Messrs. Bird and Company are selling part of their production to the Indian Iron and Steel Co. and a part to Japan. According to the estimate made by the Geological Survey

*This position has changed radically since the separation of Burma in 1937 and still more radical must have been the change since the separation of Pakistan in 1947. India's position in Petroleum production must now (in 1948) be very much lower —— Editor.

of India about 3,000 million tons of iron ore are available in northern and central India but the present production is only 3 million tons per year. There is, therefore, a very large scope for further production provided the ore can be utilised. The establishment of an iron industry requires considerable capital and, in the earlier stages foreign technical advice. After several vicissitudes, the iron industry in India appears to have come to stay and new entrants to this industry will not, therefore, have to face the same difficulties as were faced by the pioneers; but the successful development of iron ore for the manufacture of Pig Iron and Steel depends not only on capital but on the economic assemblage of various raw materials required for the metallurgy of iron and the market. For instance, a site for the works must be determined which will be relatively within easy reach of the iron ore deposits, coking coal, fluxes, the supply of water and sea-port. Fortunately for Bihar iron ore and coal are located closely but good flux, namely limestone is available at places far away from these deposits.

The present industries depend for their supplies of flux on Gangpur State and Central Provinces but this flux is not of very high grade.

Then again, taking coking coal for instance the available resources of coking coal in India are limited and they are not enough to smelt all the iron ore that is available in India.

4. Manganese.

Manganese ore, a little over 813,000 tons were mined. The steel works of India used a little over 46,000 tons and nearly 743,000 tons were exported to the United Kingdom, the United States, Japan, France and Belgium. Ferromanganese is now being manufactured in Tata Iron and Steel Co. Ltd., Jamshedpur for their own use in making steel. India and Russia are the two principal sources of the world's manganese.

5. Limestone:

Amongst the minerals for which accurate statistics are not available, Limestone and "Kankar" of which nearly 3½ million tons were quarried, would rank next to coal in importance, if weight of material only were the criterion. There has been an increased output of limestone in recent years which is due mainly to its use as a flux in the iron and steel industry, and in the manufacture of cement.

6. Bauxite

Bauxite or aluminium ore occurs in the Bihar Plateau in the Balabhat District, in the vicinity of Katni and in the Mandla District. Large deposits of bauxite also occur in the Bombay Presidency, particularly in the Belgaum District in the Kolhapur State.

Bauxite is available in very large quantities in India. At the present time bauxite bricks are not manufactured in India although the ore is occasionally mixed in small proportions in the manufacture of certain type of refractories. Bauxite is also used in the manufacture of aluminium. It is gratifying to learn that the Dalmia Industrial Group has already established a Company namely the Aluminium Corporation of India, Ltd., for the manufacture and rolling of aluminium at Asansol.

7(a) Chrome Ore

The same remarks as above apply to chrome ore but this is a matter of greater urgency. The present trend of the industry is for alloy steels, and chrome ore is one of the most important alloying element from this standpoint. It is highly to be regretted that although the chrome ore deposits of India are known to be very limited, indiscriminate export trade has been allowed in the past. This should be completely stopped.

(b) Chromite

Chromite, as a natural refractory, is of considerable use in the steel furnace where it is used either in the form of powder or in the shape of bricks to form a neutral layer between the magnesite and silica or firebricks. Chrome bricks are now being manufactured at Raniganj and Jamshedpur for the iron and steel industry.

(c) Graphite

This is used for the manufacture of refractory crucibles. The principal producers of this mineral are Ceylon and Travancore but occurrences are also reported from Kalahandi and Patna States in the Eastern States Agency. It is also found near Rajamundry where it is being mined by a local firm and made into crucibles. Graphite, rather impure, also occurs in Palamau district. Graphite shale is found in Ranchi and Singhbhum district but it requires beneficiation before it can be used.

8. Lead

Lead produced during the year was over 73,000 tons (including 1,240 tons of antimonial lead) valued at nearly

Rs. 1,72,00,000 extracted from nearly 469,000 tons of ore, mined at Bawdwin and smelted at Namtu in the Northern Shan States from which were also extracted nearly 6,000,000 ozs. of silver, valued at over Rs. 40 lakhs, 4,325 tons of nickel-speiss (containing also cobalt, copper and silver) valued at nearly Rs. 15 lakhs and 7,500 tons of copper matter valued at over Rs. 20 lakhs.

Lead smelting is now being carried on in Burma by the Burma Corporation and the reserves of this ore at the Bawdwin Mines is estimated to be about four million tons. Very little information is available about the Indian occurrences of lead or (Gelena) but deposits are reported to occur in Jailur State, Udaipur State and Khairagarh State. It is also reported to occur at Kathoria, in Bhagalpur district. The Indian occurrences should be fully investigated and the reserves estimated. India consumes large quantities of lead every year and in the year 1937 about 145,000 tons of pig lead valued at 28½ lakhs of rupees were imported into India from Burma.

9. Copper

Copper produced from the ore mined at Ghatsila in Bihar during 1936 amounted to 7,200 tons of which 808 tons were sold as copper and the remainder used in the rolling mill to manufacture brass sheets and circles.

The entire copper belt of Singhbhum should be thoroughly investigated by the Mineral Survey Department. Occurrences of copper ore are also reported from Darjeeling District and Sikkim in Bengal and from Madras, Central India and Rajputana; but detailed information is lacking. A detailed investigation should be made by the respective Provincial Governments.

10. Mica

Mica produced during the year was nearly 87,000 cwts. valued at nearly Rs. 32½ lakhs (£244,000), but the production figures are incomplete, and the export figures of nearly 178,000 cwts valued at nearly 92 lakhs (£690,000) give a better idea of the size of the industry. India is overwhelmingly the world's chief producer of high grade mica, an indispensable accessory in electrical manufactures. Most of the mica is exported to the United States and the United Kingdom which absorbed during the year 51.8 percent and 24.2 percent respectively.

Mica deposits occur mosty in Bihar. The other mica belt of India lies in the Nellore District of the Madras Presidency. Waste products in mica mining are quartz and

felspar which are required for glass industry. These also are available in plenty and are of fine quality.

11. Tin

Tin and wolfram (the ore of tungsten) occur together to a large extent in Burma and in both these minerals the production during the year was the largest on record.

12. Nickel

Nickel, as known at present, occurs in workable quantities in Burma in the Silver Mines and the ore is exported as concentrates to Hamburg (Germany) for nickel. Attempts should be made in India to manufacture nickel as well as ferro-chrome for the production of alloy steel.

13. Cobalt and Vanadium

Very little is known about the occurrence of workable deposits of these minerals but large deposits of vanadiferous iron ore have been located both in Singhbhum and Mayurbhanj which have a potential value.

14. Tungsten

Several Indian and Burmese occurrences are known but those of Burma require consideration. Ferro-tungsten is urgently required for high speed and other alloys. This mineral, therefore, is of considerable national interest.

15. Molydenum Ore

Very little information is available as to the occurrence of this ore in India but the only occurrences that have been reported upon are of academic interest. In Burma it is found associated with tungsten ore.

16. Zinc

Ancient zinc mines are reported to occur in Udaipur State, Rajputana, but no trace of the zinc bearing mineral can be found on the surface. In Kashmere there are occurrences of zinc ore in Riasi district. The quantity available does not appear to be large. There is no difficulty of generating hydro-electric power near the occurrences.

Zinc ore concentrates are produced in large quantities by the Burma Corporation Limited from its milling plant at Namtu, and are annually shipped to Belgium and Germany. There was a proposal to smelt Burmese zinc concentrates at Jamshedpur but the scheme has not yet materialised. As India consumes large quantities of zinc for galvanised sheets, brass and other alloys, smelting of zinc in India needs investigation.

17. Silica

Almost pure silica rock is available in India in many places not far from the existing iron and steel industries and the question of making ferro-silicon should deserve the attention of the National Planning Committee.

18. Magnesite

Magnesite is a very good refractory if dead-burnt to a temperature of about 1600 to 1650°C. The dead-burnt product is moulded into bricks which are used in the construction of steel furnaces. It is not affected by the molten metal and slag. Magnesite is a carbonate of magnesium and in India it is found in abundant quantities in Salem district, Madras and in Kadakola, Mysore. Both these deposits are being exploited, the former by the Salem Mining Syndicate and the latter by the Tata Iron and Steel Company, Limited. Dead-burnt magnesite is also used in pea-size form for the hearths of steel making furnaces. The consumption of magnesite in India at the present time is small and the Tata Iron & Steel Company is the only major consumer. With the advent of other steel companies, the consumption will increase. However the Indian reserves are enough to meet future demands.

19. Dolomite

Dolomite, when dead-burnt to a temperature of 1600 to 1650°C yields a very good refractory. In India good dolomite is available in large quantities, but those occurring in Gangpur State, Eastern States Agency, are the purest. The Tata Iron & Steel Company obtains its supply of refractory dolomite from the Gangpur deposits.

20. Chrome Magnesite

A combination of chrome and magnesite has been found to be very suitable for the manufacture of chrome magnesite bricks for use in the construction of steel furnaces. It is widely used in America and Europe. Chrome-magnesite brick is finding increasing use in the construction of basic steel furnaces partly replacing silica brick.

21. Silica Rock or Ganister

Silica rock or ganister of suitable composition is available in large quantities in many places in India but is chiefly found in the coal mines of Bengal and Bihar and in the metamorphic rocks in Bihar, especially near Rajgira and Ghatsila. This rock is the principal source of material for silica brick and silica cement. Two firms are now

manufacturing silica brick near Raniganj and Jharia and their products are consumed in very large quantities in the Tata Iron & Steel Company's Plant at Jamshedpur. There is no dearth of this material within easy reach of the coal fields and India should be able to take care of any increased demand in future. Silica cement can also be made from crushed silica rock. It is, however, necessary to mix suitable clays or other products with it to impart to it the plasticity required.

Silica bricks are considerably in use in the construction of modern coke ovens and are also used in the construction of open hearth steel furnaces.

22. Quartz Mica Schist and Quartz Kyanite Schist

Quartz mica schist and quartz kyanite schist are available in many places in India but at present the chief source of supply is from a deposit near Ghatsila. This rock is used as an acid lining for steel converters in the Duplex process of steel making at Jamshedpur. The rock generallly contains about 85% silica and should be very low in iron and alkaline in order to withstand a temperature of over 1400°C. The proportion of mica in the rock should be low but a small presence of it is helpful in trimming the rock to the desired shape.

23. Kyanite, Sillimenite and Andulusite

The value of kyanite, sillimenite and andulusite as refractory materials on a commercial scale came into prominence after the discovery of deposits of sillimenite in Assam and of kyanite in Kharesowan State. The massive compact rock is the one generally used for refractory purpose. These three minerals have the same chemical composition.

Kyanite being more easily available than sillimenite or andalusite is principally used for the manufacture of kyanite bricks but for this purpose it is first heated to a temperature over 1500°C and then crushed and moulded into bricks with some suitable bend. Owing to the high cost of making the bricks, their use is much restricted. As there are considerable deposits of kyanite in India there will be no difficulty in meeting future demands. Kyanite bricks are extremely suitable in the construction of furnaces for glass making and other ceramic products. It has not come into wide use in the iron industries, because it is badly affected by iron oxides.

24. Fireclay

The name "Fireclay" is practically applied to all clays which can stand a high temperature and those clays are found to be widely distributed in the coal measures of India. Of the fireclays those that are plastic are highly valued. Fireclays are now being worked in many places in the coal fields and Tatas hold large deposits near Balpahar in the Ibcol measures. Firebricks are made from fireclays and there are several companies in India which have suitable plants for making firebricks. Large quantities are consumed annually by the steel, sugar and cement industries. Indian made firebricks have proved equal in strength and durability to the best obtainable in any other country.

25. Zircon

This is considered to be a very good refractory with a melting point of about 2200°C. Zircon sand is available in Travancore and is now exported.

26. Asbestos

Asbestos has fire and acid resisting properties and has therefore a variety of uses. Mixed with cement and other substances it can be used for the manufacture of tiles, sheets and fireproof coverings. It occurs in several places e.g., Seraikells, Mysore, Bhandra (C.P.) Idar State, Bombay, Ajmere-Merwara, Rajputana and Cuddapah.

27. Flourspar

Flourspar is an important fluxing agent in the steel furnaces. All Indian occurrences are unfortunately poor both in quality and quantity.

28. Shellac

The cultivation of lac is practically an Indian monopoly. It is grown over a very wide area including Assam and Burma. However the chief areas of cultivation are Chota Nagpur, the Feudatory States of Orissa and the Central Provinces. They produce about 90% of the lac of commerce. The annual production of lac in India varies between 800,000 and 1,600,000 maunds. The export of shellac of all kinds varies from 400,000 to 800,000 cwts., valued at approximately 2 to 2½ crores of Rupees. Shellac is used in the electrical insulating materials, gramophone records, protective and decorative finishes, manufacture of sealing wax, grinding wheels etc.

APPENDIX II

SYNOPSIS SHOWING THE POTENTIALITY OF VARIOUS PROVINCES AND NATIVE STATES IN INDIA FOR INDUSTRIAL DEVELOPMENT.

Province.	Area in miles.	Population	Agricultural products.	Forest products.	Mineral Resources.	Major Industries.	Minor Industries.	Total No. of industries.	Industrial employment.	Characteristic features.
Bengal	80,000	50,122,550	Jute. Rice. Wheat. Pulses. Tobacco. Sugar Cane.		Coal.	92 Jute Mills. 22 Cotton Mills. Bengal, Iron and Steel Corporation at Kulti. Coal Mining at Raniganj. Dunlop Rubber Co. in Calcutta.	Hosiery. General Eng. Workshops.	1667	5,132,35	Virtual monopoly in jute production employing 2,78,000 men and operating 11,94,000 spindles.
Bombay Presidency.	151,953	26,347,419			Building stone and Salt.	195 Cotton Mills centre being : (*a*) Bombay Proper. (*b*) Ahmedabad.	Silk and wool, Match Factory, Refining & smelting of nonferrous alloys. Bakelite material moulding. Electric Fans.	1999	420,716,	Cotton industry is the principal industry, fitted with 1.4 lakhs of looms. Establishment of Aluminium Manufacturing Co. under consideration.
Bihar	83,000	32,289,958	Sugarcane & Lac.		*Coal*, Salt petre, *Mica*, Salt, Ballast, limestone, *Iron*, *Copper & Manganese ores*, Slate, Steatite, Fire-clay, China-clay, Sand stone Lapatite and Kyamite.	*Tata Iron & Steel Co.*, Jamshedpur. Indian Cable Co. Jamshedpur Wire Products Jamshedpur. Tinplate Co. Jamshedpur. Pensylvania Locomotive Workshop Jamshedpur. Tatanagar Foundry Jamshedpur. Hume Pipe Co.,	4 Sugar Factories Cloth weaving. Tassur Silk, Cotton Carpets, Stone Carving, Potteries, Oil Mills, Indigo, Glassware.	309	86,327	Iron & Steel Works at Jamshedpur which city is well recognised as the Pittsburgh of India. Lac Institute at Ranchi.

Province.	Area in miles.	Population.	Agricultural products.	Forest products.	Mineral Resources.	Major Industries.	Minor Industries.	Total No. of industries	Industrial employment.	Characteristic features.
Bihar—(*contd.*) ..						Jamshedpur. Tata Chemical, Jamshedpur. Tata Agrico, Jamshedpur. Railway Workshop at Jamalpur. Lac Industry.				
C. P.	130,000	17,951,147	Rice and food grain	Teak, Sal, Lac, collected in Forests	*Manganese, Iron, Coal, Bauxite* & Copper.	Cotton Factories (12) Cement.	Match Factories (3) Glass Works Lime & Pottery.	1,033	63,186	Cotton industry and mining of Manganese ore.
Assam	26,000	9,247,857	Rice. Tea. Jute. Tobacco. Various kinds of spices.	Timber and Slappers.	*Coal*, limestone, Pertoleum, *Oil*, iron, Platium, lead and Silver.	Tea (both black & green factories.)	Rice Mills (21) Pipe & Pottery Works. Paper Pulp. Petroleum refining.	706	47,557	*Tea.* There were 1,103 tea gardens. Labour Force being 5,05,237, Permanent labour figure being 4,47,263.
U. P.	110,000	49,614,833	Wheat, pulses, millets maize, barley, rice, sugar & cotton.	Semul and Guntil.	Peat, Coal, Iron, copper in small quantities, *limestone*.	Textile Mills Tanning. Sugar Factories. Leather goods Glass.	Soap, Paper, Match & Cigarette, Lock & padlocks, Utensils, Potteries.	496	139,260	Chief Centre of Sugar Industry.
Punjab	100,000	23,580,851 (exclusive of Indian States)	Wheat. Tobacco Sugarcane. Cotton. Millets. Oilseeds. Maize. Bajra. Jowar.	Sal.	Coal. Petroleum. Salt mixed with gypsum, Rock salt, copper, iron to some extent, Salt petre, carbonite of soda, salt ammoniac.	Textile Industries. Hosiery Works (17) Woollen goods manfg. Sports Goods. Resins. Cements. Rice Mills (26) N. W. R. Workshop.	Glass. Chemicals (5) Soap. Oil Mills (5) Flour Mills (15) Carpet industry.	720 actually working (598.)		Centre of Hosiery Industry.

Province.	Area in miles.	Population.	Agricultural products.	Forest products.	Mineral Resources.	Major Industries.	Minor Industries.	Total No. of industries.	Industrial employment.	Characteristic features.
Madras Presidency .	142,000	53,503,043	Rice and millets, Pulses, rubber & *indigo*, *chinchona*.	Teak, ebony, Sandalwood.	Manganese, salt. Saltpetre, Clay granite. Laterite, *coal* (inferior) *iron*, *mica*, *magnesite*.	Weaving of Silk. Cotton factories (36) Cheruts & Cigar. Rice mills (323) Brick & tiles (58) Leather factories (14) Cotton ginning & pressing factories (422)	Metal Factories, factories for silver, brass and copper. Saw mills (10) Bone mills (8) Jute Mills (4) Hosiery (12)	not available.	not available.	36 Cotton mills with 976,000 spindles, 6,00 looms employing re : 696.
N. W. F.	36,356	2,425,076	Wheat. Rapet. Mustard. Barley. Cotton Sugarcane. Dry fruits.				Ice factories (3) Gin & press (2) Ordnance factories (5)	26		
Orissa	30,009	3,000,000	Rice. Turmeric. Spices. Coconuts.	Yields wood mainly for building, and sandal wood.	Coal, iron, copper, mica, manganese ore.		Bell metal wares. Horn articles. Cutlery.			Abundance of Rice and fish.
Sind	50,000	1,706,116	Cotton. Rice. Pulses.							Better quality of cotton.
Akalkot	498	92,605	Jowar, Baira. Ground nuts, cotton and linseed.	Firewood.						
Alwar..	3,177	749,751	Wheat. Barley. Piecegoods.			Cotton Weaving and Dyeing.				

Province.	Area in miles.	Population.	Agricultural products.	Forest products.	Mineral Resources.	Major Industries.	Minor Industries.	Total No. of industries.	Industrial employment.	Characteristic features.
Baroda	8,135	2,443,007	Cotton. Rice. Wheat. Pulses. tobacco.			Cotton Mills (15) Woollen Mill (1) Chemical Works (2) Metal factories (3)	Salt factory. Cement factory.			
Bagter	13,725	5,22,283	Rice and rape seed.	Teak, sal, myroballan, lac, wax, honey, tanning bark, Tassar, cocoons.	*Iron* in large deposite and *mica*					
Bhavnagar	2,960	500,274	Cotton. Grains.			Oil Mills. Copper vessels Cloth weaving. Cotton pressing and spinning and weaving mills.				
Bikaner	23,317	9,36,218	Bajra. Jowar. Omoth.		Ligaite. Gypsum. Fire-clay. Limestone.	Wool baling press (1) Wool cleaning factory (1) Oil Mills. Pulse grinding factories.	Glass. Potteries. Ice factories. Tanning and soap factory. *Vacuum pan sugar factory.*			Wool shipment.
Bhutan				Timber. Rubber. Honey.						Rubber.
Cochin	1480	1,205,016	Paddy. cocoanuts. peas, leaves. areca nuts.	Teak. Rubber. Rosewood.	Laterite.	Oil pressing and coir works based on cocoanuts. Ceramic Works. Tile factorys (35) Textiles (2) Stoneware Match factory.	Fish curing. Areca nuts curing Bell metal works and casting.			Cocoanuts and areca exports.

Province.	Area in miles.	Population.	Agricultural products.	Forest products.	Mineral Resources.	Major Industries.	Minor Industries.	Total No. of industries	Industrial employment.	Characteristic features.
Cooch Bihar ..	1,318	590,866	Tobacco. Rice. Jute. Sugar-cane. Mustard seed.				Rough cloth from silk tending worms are woven Gunny cloth. Ghee & mustard oil.			
Cutch	7,676	513,829	Wheat. Barley. Cotton. Grains. Pulses.		*Iron* (not smelted now by old process.) *Coal* (cannot be mined). Alum, Salt petre. Yellowish marble.	Silk and Cotton (cloth).	Silver ware. Embroidery and silver work.			Famous for quality horses.
Dhar	1,777	243,430	Wheat. Grain. Jowar. maize.			Cotton weaving. Ornamental work Tanning and oil pressing. Pressing of cotton fabrics. Opium manufacturing.	Toy making. Gun making. Bidis from tender leaves.			
Dhrangadhra ..	1,167	88,961	Cotton. Grains.		Black magnesia rocks.	High grade salt manufacturing. Soda alkalies as a bye-product in salt manufacture. Mg. C12 manufacturing. Ginning factories. (4) Cotton press (1)	Tussur cloth. Copper & brass works. Utensils making. Handmade cloth work.			
Dhrol	2,827	27,653	Sugarcane. Grains. Molasses.				Coarse cotton cloth woven and hand looms.			

Province.	Area in miles.	Population.	Agricultural products.	Forest products.	Mineral Resources.	Major Industries.	Minor Industries.	Total No. of industries.	Industrial employment.	Characteristic features.
Gondal	1,024	205,846	Cotton. Groundnuts. Foodgrains. Sugarcane. Rice.			Oil Mills. Hand mills for cotton. Grinding and pounding and husking of rice. Production of "Crystal sugar". Cotton presses (2) Ginning factories. (9) Cotton & wool weaving.	Ice factory. Tanning hides. Wood works. Weaving of blankets.			
Gwalior State ..	26,430	35,23,070	Wheat. Jowar and grains. Pulses and maize. Rape and mustard. Saran and hemp. Cotton. Sugar.	Teak. Salar. Lac. Tanning and Semi, oil yielding and colour dyeing plants.	*Bauxite*, iron ores Mang. ore. Galena, copper, iron, pyrites, green earth pottery clays, ochres, mica, limestone, quartz, sandstone and saltpetre.	Leather factory. Potteries Printing press. Cotton spinning & weaving mills (7) Carpet works. *Taxidermy* Cement factory. *Sugar mills.* Match factory. Flour mills. Ginning and cotton presses (122)	Hosiery. Tobacco. Nib factory.	432		Famous for her mineral resources and cotton and weaving factories.
Holkar	9,902	13,25,089	Opium poppy. Cotton.			Cotton industry (7) Rubber and Tyre works.	Distilleries. Crude opium.			Cotton spinning and weaving.
Hyderabad	82,698	14,436,148	Cotton. Wheat. Rice. Linseeds. Indigo.	Acacia. Arabica. Timber.	Diamonds. Gold and Coal.	Cotton manufacturing. Ginning and pressing (272) Spinning and weaving mills. Paint works.	Sword, blades, daggers, knives, and cutlery works etc. Brocade silver and gold, woollen silks.			Diamonds.

Province.	Area in miles.	Population.	Agricultural products.	Forest products.	Mineral Resources.	Major Industries.	Minor Industries.	Total No. of industries	Industrial employment.	Characteristic features.
Indore	9,520	1,318,237	Cotton. Opium. Paper.			Cotton mills (7) Cotton ginning & pressing. Flour mills (193) Small factories iron & brass (21)	Sugar factory.			
Jagrabad	53	12,092	Bajra. Jowar. Groundnuts. Cotton. Wheat.				Coarse cotton cloth is manufactured by country weavers. Stone quarried for manufacture of lime.			
Jaipur	15,579	2,632,775	Mung. Baira. Math. Cotton. Tin.				Woollen cloth and fabrics are woven. Cotton presses. Marble work, enamel work and brass works.			
Jodhpur	36,021	21,25,982			Salt at Sambhar.		Weaving of woollen cloth, is carried in villages. Dyeing and printing of cloth. Tanning.			
Junagadh	3,337	5,54,889		Teak. Blackwood. Jambu. Babul.	Stone of good quality is found for building purposes.					
Karauli		1,40,525	Bajra. Paddy. Til. Cotton. Wheat and barley.			Manufacturing of Tat and pabits. Dyeing and printing cloth. Lacquer, tanning, etc. Moulding of brass and pewter ornaments.	One ginning and flour mill. Stone carving.			

Province.	Area in miles.	Population.	Agricultural products.	Forest products.	Mineral Resources.	Major Industries.	Minor Industries.	Total No. of industries.	Industrial employment.	Characteristic features.
Kashmir ..	86,471	36,764,95	Rice. Wheat. Barley. Linseed. Sesamun. Saffron.	Deodar. Pines. Sprance. Willow. Wood, and bamboos. Rearing of silk worms. Precious stones.	Coal, iron, gypsum, lime-stone, copper and nickel bauxite, lead, manganese, Arsenic, Chromate, ochre, graphite, Kaolin, Bentorite, Fuller's earth, marble, slate, stealite, *Gold*. Oil is also expected.	Carpet making shawls, embroideries, etc. Gold and Silver work. Timber extraction	Hand and craft works.			Famous for her minerals and abundance of fresh and dry fruits.
Kathiawar	24,000	27,00,000	Cotton. Wool.		Different kinds of building stones iron, pearls of quality.	Weaving Mill, Steam presses for treating cotton and wool. Essence and allied works.	Kathiawar crafts gold, silver threads, making of silk threads. Ivory, work and carving of sandal wood, etc.			
Limbdi ..	343	40,084	Cotton. Grain. Wheat.				Coarse cloth is made to some extent.			
Manipur	8,638	4,45,606	Cotton. Grain. Sugarcane. Millets. Maize and Linseed.				Leaves that cover the crops of maize are used for making cheroot (of inferior quality).			
Morvi	822	1,13,024				Ginning factories. (8) Cotton fabrics manufacturing. Metal utensils, ivory work, gold and silver thread. Pottery works. Glass factory.	Weaving and spinning mills. Baling press. Salt factories. Glazed earthernware, etc.			

Province.	Area in miles.	Population	Agricultural products.	Forest products.	Mineral Resources.	Major Industries.	Minor Industries.	Total No. of industries	Industrial employment.	Characteristic features.
Mysore		65,57,871	Jowar. Rice. Gram and pulses. Sugarcane. Castor oil. Cotton. Sann and hemp. Tobacco. Cumin seeds.	Teak. Sandal-wood. Coffee. Black-wood. Lac. Tanning barks. Gum and honey. Soap nuts. Fuel from forest.	*Iron, Gold,* from Kolar, Chromite, Kaolin, Kyanite, Staurolite, Garnet, Green quartz, Soap-stone, Galena, Antimony, graphite.	Mysore Iron and Steal works, Bhadravati. Cotton weaving and Silk works. Steel wire drawing factories. Brass and copper works. Bell metal articles. Tanneries and carpet factories. Soap, sandalwood and oil factories.	Ornamental work, carving of sandal wood. Rice and Flour mills. Sugar factory. Brick and tile factory.			1,20,000 persons are employed in hand looms weaving, there being 40,000 looms of which 30,000 for cotton and 10000 for woollen fabrics and Sandalwood oil.
Nawanagar	3,791	4,08,851	Grain. Cotton. Wheat.		Marble of different qualities.	Cloth and Silk Factories and Dyeing.				
Palitana	288	62,150	Grain. Sugarcane. Cotton.			Cotton trade.				
Porbunder	642½	1,15,742			Limestone.	Silk manufacturing. Indian cement Co. Ltd. Maharana spinning and weaving mills. The Nadir Salt works.				
Pudukotah		4,00,000				Stone products & earthern ware, utensils, weaving of cloth, Aluminium utensils. Tanning and dyeing. Fragrant oil and perfumed sticks.				

Province.	Area in miles.	Population.	Agricultural products.	Forest products.	Mineral Resources.	Major Industries.	Minor Industries.	Total No. of industries.	Industrial employment.	Characteristic features.
Rewa ..	1,300	15,87,445			Coal, limestone, sandstone, marble, iron ore and copper, ore, Ochres.	Lime Factories.				
Bhawalpur ..	15,000	9,84,612	Wheat. Rice. Millet. Grain. Sugarcane. Cotton.			Silk lungies and silk cloth and metal cups are manufactured. Cotton Mills. Porcelain vessels etc.	Crude Soda.			
Nabha		2,87,574	Grain. Wheat. Pulses. Cotton. Sugarcane.		Salt-petre.	Silver and gold ornaments. Brass utensils. Cotton presses. Ginning. Oil mills.	Lac. Cotton factory. Carpets.			
Rajkot	290	75,566	Grain. Sugarcane. Cotton.				Cotton and woollen cloth is manufactured.			
Sawantwadi ..	930	2,30,589				Wooden lacquered goods and tanning factories. Rice mills (8)	Flour mills. Bidi factories (10)			
Travancore ..	7,624	50,95,973	Pepper, tea, dry, ginger, Tamarind and coffee gardens.	Timber.	Monalite, Ilmenite, Zircon ore separated from sand.	Cotton weaving. Coir mat making. Brick and tiles. Cocoanut oil. Paper factories. Roasting and packing of cashewnuts. Rubber factory.	Scheme for starting clay refining and procelain factory is in progress.			

Province.	Area in miles.	Population.	Agricultural products.	Forest products.	Mineral Resources.	Major Industries.	Minor Industries.	Total No. of industries.	Industrial employment.	Characteristic features.
Dankanar	417	43,307	Grains. Sugarcane. Cotton.		Black marble.	Ginning factories.				
Udaipur	1,052	97,730			Lead, Zinc, Iron ore, White marble and sandstone.	Daggers, swords making. Ivory works. Tin utensils. Cotton cloth printed in gold and silver.	Embroidery work. Stone toys.			
Burma	2,37,000	14,655,618	Rice. Cholum. Maize. Gram. Groundnuts. Tobacco.	Teak. Various other kinds of wood, etc. India rubber tree. Oak. Pines. Pyringado. Padauk.	Petroleum, tin, oil, iron, ore, gold, salt, silver, lead, alabaster, steatite, mica, copper and plumbago.	Rice mills (647) Cotton ginning (33) Oil mill (29) Saw mills (112) Cotton mill (1) General Eng. Works (18) Printing presses (19) Petroleum refineries (9) Lead melting and rolling mills (2) Ship-building workshops (3)	Hosiery (2) Knitted underwear mills. Ice and aerated water factories (13) Flour mills (4) Match factories (4)	965		Rice mills and wood forests.
Nepal	56,000	55,80,000	Rice. Wheat. Millets. Maize. Oil seeds. Sugarcane.		Rock deposits for lime and cement factories, mica, cobalt, asphalt, antimony, iron, copper and coal.					

APPENDIX III

A GENERAL IDEA OF INDIAN RAILWAYS' ADMINISTRATION, FINANCE, AGREEMENTS AND CONTRACTS

Railway development in India dates back to 1853 when the Great Indian Peninsula Railway constructed their first line extending from Bombay to Kalyan. Since then the mileage of Indian railways has recorded steady increases till this now stands at about 43,118 miles, of which 31,783 miles were under State Management.

One of the special features of the Indian Railway system is the diversity of conditions that prevails in the relation of the State to the various lines in respect of ownership and control. Of the important lines situated in British India or in which the Government of India is interested five [the North Western, Eastern Bengal, East Indian (with which has been amalgamated the Oudh and Rohilkhand Railway from the 1st July 1935), Great Indian Peninsula and Burma Railways] are owned and worked by the State; five (the Bombay, Baroda and Central India, Madras and Southern Maratha, Assam Bengal, Bengal Nagpur, and South Indian) are owned by the State but worked on its behalf by Companies enjoying a guarantee of interest from the Government: two important lines (the Bengal and North Western, and Rohilkhand and Kumaon) and many of less importance are the property of private companies, some being worked by the owning companies, and some by the State or by the companies that work State-owned systems. Several minor lines are the property of District Boards or enjoy a guarantee of interest granted by such Boards.

Railway Finance:—Under the separation convention, which came into effect since 1925-26, the Railways in India are liable to make a contribution to general revenues which amounts on the average to a net payment of Rs. 6 crores a year. Of the thirteen years that have elapsed since the separation of railway revenues from the general revenues of India, the first six were prosperous years. After paying interest charges, and putting by a net sum of Rs. 12 crores in the Depreciation Fund after meeting such of the expen-

diture on renewals and replacements as is chargeable under rules, to the Fund, the total surpluses amounted to Rs. 52½ crores. During the next five years, the position was very different. There were successive deficits of Rs. 5.19, Rs. 9.20, Rs. 10.23, Rs. 7.96 crores, Rs. 5.06 crores and Rs. 3.99 crores during the years ending 1935-36. During 1936-37 there was a surplus of about 1¼ crores. During the period of prosperity, Railways met all their liabilities, and even in 1930-31, the first year of depression, they contributed 5¾ crores to general revenues. This contribution was, however, met from accumulations in the Railways Reserve Fund. In all, during this period, after meeting all their liabilities, Railways contributed 42 crores to general revenues. After 1930-31, Railways have made no contribution to general revenues, and have only been able to meet working expenses and interest charges by borrowing from the depreciation reserve fund. The total amount borrowed from this fund up to the end of 1935-36 was 31½ crores, and the actual balance in that fund had been reduced at the end of that year to 5½ crores. During 1936-37 Rs. 121 lakhs was paid back to the Depreciation Fund. It should be noted, however, that since the contribution to general revenues has ceased, Railways have taken over the responsibility for loss on strategic lines—about 2 crores per annum.

At the end of 1936-37, the unliquidated liabilities of railways amounted to Rs. 61 crores, of which Rs. 30¼ crores is the amount borrowed from the depreciation fund. The balance of Rs. 30¾ crores represents the contributions due to general revenues but unpaid from 1931-32.

Railway Profits:—It is interesting to notice that during the last 13 years, of which the first six were prosperous, the State has received large profits from 7 Railways, namely, Rs. 19½ crores from the East Indian Railway, 18¼ crores from the Bombay Baroda and Central India Railway, Rs. 6¼ crores from the South Indian Railway, Rs. 6 crores from the Bengal and North-Western Railway (Trihoot), Rs. 5 crores from the Madras and Southern Maratha Railway, Rs. 1¾ crores from the North-Western Railway Commercial Lines and about Rs. 1 crore fom the Lucknow-Bareilly. On the other hand, it had to bear losses on 6 railways. The largest is about 24.3/8 crores on the strategic section of the North Western Railway, and the next largest Rs. 16.2/3 crores on the Bengal Nagpur Railway. On the Assam Bengal Railway, the loss amounts to Rs. 5 1/3 crores. The Eastern Bengal, Burma and Great

Indian Peninsula Railways are responsible for losses of Rs. 5, Rs. 2 and Rs. 1 3/8 crores respectively.

Capital:—The total capital at charge at the end of March, 1937 on all railways including those under construction amounted to Rs. 880.13 crores of which Rs. 789.03 crores pertaining to State-owned railways inclusive of premia paid in the purchase of companies lines. The balance of 91.10 crores represented capital raised by Indian States, Companies and District Boards.

Works Expenses:—The total works expenditure during the year amounted to Rs. 8.16 crores of which Rs. 28 lakhs was charged to capital and the balance to the Depreciation Fund.

The Gauge of the Indian railways may be chiefly classified under three heads:—

Standard — (5 ft. 6 in.) Gauge,
Metre — (3 ft. 3 3/8 in.) gauge, and
Narrow — (2 ft. 6 in. and 2 ft.) gauge.

East Indian Railway System

Hardwar Dehra Railway (5'—6" Gauge)

Main provisions of agreement and contract:—

(I) **Land.**—Provided by the Government free of cost to the Company.

(II) **Government aid.**—The line is the property of the Hardwar Dehra Branch Railway Company, and was constructed from funds supplied by the Company, by the Government, who maintain, stock and work it through the agency of the East Indian Railway.

The Government guarantee interest at 3 per cent, per annum on the capital expenditure, and also undertake to allow to the Company, in any year in which it does not receive the minimum dividend of 3 per cent from the earnings of the line, the sum of Rs. 3,600 for such year for or towards management and office expenses.

(III) **Terms of working.**—For maintenance, provision of rolling stock and working, the East Indian Railway Administration retains 50 per cent of gross earnings of the Branch line.

(IV) **Distribution of profits.**—The surplus profits in each year remaining after repayment to the Government of the amount of the gauranteed

interest for the year are to be divided equally between the Government and the Company.

Bengal Provincial Railway System

Dasghara-Jamalpurgunj Railway (2ft. 6 inches gauge)
Main Provisions of Contract:

(I) **Land.**—Land in British territory provided free of cost to Company.

(II) **Government aid.**—When the net receipts shall not be sufficient to pay interest at the rate of 3½ per cent. per annum on the paid up share capital of the Company in respect of this railway, the Secretary of State shall pay such sum as shall, together with a proportion, specified below, of the net receipts, make up an amount equal to interest at 3½ per cent on the same proportion of the share capital. The proportion referred to is that which the paid up share capital, less any capital spent on additional rolling-stock provided in respect of this railway, bears to its paid up capital.

(III) **Terms of working.**—The line is managed, maintained, provided with rolling-stock and worked for the same percentage of its gross earnings as the working expenses of the whole system bear to the gross earnings of that system, provided that the working expenses of this line shall not exceed 50 per cent of its gross earnings and that the cost of any rolling-stock for the jointworking of the system shall be divided between and charged to the capital account of the railways forming the system in proportion to their respective mileage.

(IV) **Dasghara-Jamalpurgunj Railway (2'-6" gauge)—Distribution of profits.**—If the net receipts shall exceed the minimum amount sufficient to pay interest on the paid up share capital at the rate of 5 per cent, per annum such excess shall be divided equally, and one moiety shall be paid to the company; and of the second moiety a proportion, as specified in (ii) above shall belong to the Secretary of State and the balance shall be paid to the Company.

If the net receipts do not amount to a sum sufficient to pay interest at the rate of 5 per cent

per annum, the whole of such net receipts shall belong to the Company.

Burdwan-Katwa Railway (2'-6" gauge)

Main Provisions of the Contract

(I) **Land.**—Provided by Government free of cost to the Company.

(II) **Government aid.**—When the net receipts are not be sufficient to pay interest at the rate of 3½ per cent per annum on the paid-up share capital, the Secretary of State shall pay the Company a sum which together with the net receipts will make up an amount equal to 3½ per cent. When the net receipts for any year do not exceed 5 per cent per annum on the paid-up share capital the whole of such net receipts shall belong to the Company. When the net receipts in any year exceed 5 per cent on the paid-up share capital such excess shall be divided equally between the Secretary of State and the Company.

(III) **Distribution of profits.**

Main Provision of Agreement and Contract

(I) Land—Provided by the Government free of cost.
(II) Government Aid.
(III) Terms of working
(IV) Distribution of profits.

The line (which is the property of the District Board of Guntur) is maintained and worked as an integral part of the Company's system by the Madras and Southern Maratha Railway Company, who provides the rolling stock and other appliances, etc. necessary thereunto.

For these services, the Secretary of State is to receive half-yearly 50 per cent of the gross earnings of the Branch, the balance, after meeting the cost of new minor works and any expenditure incurred on the Branch on account of extraordinary casualty such as bursting of dams, etc. being handed over to the District Board.

By way of rebate, the Secretary of State is to pay in respect of and at the end of each financial year such a sum not exceeding in any year the net earnings (exclusive of earnings derived from the carriage of revenue stores) from traffic interchanged between the Company's Railway and the Branch as shall together with the aforesaid balance of

gross earnings of the Branch make up an amount equal to interest at the rate of 3½ per cent per annum on the Capital cost of the Branch. This undertaking shall be subject to the proviso that when the aforesaid balance of gross earnings of the Branch without the assistance of a rebate, suffices to pay interest at a rate exceeding 3½ per cent on the capital cost of the Branch, the surplus shall be divided equally between the Secretary of State and District Board.

APPENDIX IV

A GENERAL IDEA OF FERROUS AND NON-FERROUS ALLOYS USED IN THE MANUFACTURE OF MOTOR CARS

I. CAST IRON:

	T.C.	Mn.	Si.	S.	P.
Soft Castings	3.5	.75	2.85	.05	.50
Hard Castings	3.30	.75	2.85	.05	.50
Jobbing Work	3.45	.62	2.30	.05	.33
Cylinder	3.40	.60	2.20	.08	.35
Piston Pots	3.50	.60	2.25	.05	.43

II SHEET STOCK.

	C.	Mn.	S.	P.	Si.
Mild sheet steel cold rolled ..	.20 Max.	.60 Max.	.04 Max.	.04 Max.	
Mild sheet steel hot rolled ..	.15—.30	.25—.60	.05 Max.	.05	.50 optional
Carbon steel for frames ..	.25—.32	.60 Max.	.105	.05	Silicon .25 max.
Carbon steel for clutch plates.	.70—.80	.50—.80	.05	.05	.30 max.
Nickel steel for frames ..	.20—.30	.60	.04	.04	Nickel 2.50-3.50

III STEELS

	Type of Steel	Carbon	Manganese	Chromium	Vanadium	Tungsten	Nickel	Silicon	Phosphorus	Sulphur
1.	Carbonized stock	.17— .22	.60—.75	.65— .80	.12— .15	....	....	.10— .15	.03 Max.	.04 Max.
2.	Shafts & Axles	.20— .22	.65—.75	.80— .95	....	....	....	.10— .20	.03 „	.04 „
3.	„ „	.26— .32	.65—.80	.80—1.00	....	....	....	.10— .20	.03 „	.04 „
4.	Gears	.30— .35	.65—.80	.90—1.00	....	....	....	.10— .20	.03 „	.04 „
5.	Worm Gears	.42— .47	.70—.90	.85—1.10	....	....	....	.10— .20	.03 „	.04 „
6.	„ „	.48— .52	.70—.90	.85—1.10	....	....	....	.10— .20	.03 „	.04 „
7.	Spring Steel	.45— .52	.80—.95	1.00—1.20	....	....	....	.10— .20	.03 „	.04 „
8.	„ „	.48— .52	.80—.95	1.00—1.20	....	....	....	.10— .20	.03 „	.04 „
9.	N. Carbonised stock	.10— .15	.25—.40	.25— .35	....	....	....	.10— .20	.03 „	.04 „
10.	Die Block	.75— .80	.30—.40	3.75—4.75	.90— 1.0	....	....	.20— .30	.03 „	.04 „
11.	Ball race	.95—1.05	.30—.40	1.25—1.50	....	....	....	.20— .30	.03 „	.04 „
12.	Ball bearing	.95—1.05	.20—.30	.40— .50	....	....	....	.20— .30	.03 „	.04 „
13.	„ „	.95—1.05	.20—.30	.90—1.10	....	....	....	.20— .30	.03 „	.04 „
14.	Magnet	.80— .90	.30—.45	1.90—2.1	....	.75— .90	....	.25— .40	.03 „	.04 „
15.	4½ temper	.95—1.05	.20—.30	.20 max.	....	....	....	.15— .25	.025 „	.03 „
16.	3½ temper	.70— .80	.25—.35	.20 „	....	....	....	.15— .25	.025 „	.03 „
17.	Coil Spring	.60— .70	.70—.85	....	....	....	....	.15— .20	.03 „	.04 „
18.	Carbon Spring	.85— .95	.30—.45	....	....	....	....	.10— .20	.03 „	.04 „
19.	G. Carbonised stock	.15— .20	.30—.45	....	....	....	....	.07— .15	.04 „	.05 „
20.	GG. Shafts	.20— .25	.30—.45	....	....	....	....	.07— .15	.04 „	.05 „
21.	H „	.27— .37	.45—.60	....	....	....	....	.07— .15	.04 „	.05 „
22.	L Frame	.23— .30	.35—.50	....	....	....	....	....	.04 „	.05 „
23.	E. Shafts	.27— .35	.70—.90	....	....	....	....	.07— .15	.04 „	.05 „
24.	EE Shafts	.35— .40	.70—.90	....	....	....	....	.07— .15	.04 „	.05 „
25.	Machine	.08— .20	.35—.50	....	....	....	....	.10— .20	.04 „	.05 „
26.	Low COH	.08— .15	.35—.50	....	....	....	....	....	.04 „	.05 „
27.	Welding Wire	.10 Max.	.20 Max.	....	....	....	....	....	.02 „	.03 „
28.	Bessemer	.09— .13	.70—.90	....	....	....	....	....	.10—.15	.09—.11
29.	Special H. S.	.60— .70	.25—.35	3.75—4.25	.90—1.10	17.0—18.0	....	.20— .30	.03 Max.	.04 Max.
30.	Armature Steel	.05 Max.	.30 Max.	....	....	....	....	.12— .28	.03 „	.04 „
31.	Electrical steel	.05 „	.30 „	....	....	....	....	.90—1.20	.03 „	.03 „
32.	Ni. Key stock	.25— .35	.50—.80	....	....	....	3.25—3.75	....	.04 „	.045 „
33.	Ni. Bolt stock	.20— .28	.40—.50	....	....	....	3.50 Min.	.10— .15	.03 „	.04 „
34.	C. Key stock	.30— .40	.50—.80	....	....	....	....	.10— .20	.05 „	.05 „

Resolutions of the National Planning Committee on the Report of the Sub-Committee for Engineering Industries including Transport Industries

The Final Report of the Sub-Committee on Engineering (including Transport) Industries was presented by Mr. Ratanchand Hirachand, a Member of the Sub-Committee, on the 2nd May, 1940. The Secretary, the Hon'ble Mr. M. N. Dalal was unable to be present. The consideration of the Report was concluded the same day. The following resolutions were adopted:—

(i) The National Planning Committee having considered the Report of the Engineering Industries and Transport Industries Sub-Committee resolve that this should be forwarded to the National Planning Commission, when this is constituted. The Committee agree and are firmly of opinion that the establishment of a heavy engineering industry for the manufacture of heavy machinery of all kinds, heavy forgings, boilers, machine tools, locomotives, railway carriages and wagons, heavy engines etc., is essential for the advancement of India, the development of her industries and for the organisation of defence. Such a key industry is the foundation for all Planning. It is necessary that all machinery required in India should be made in India, except in very special cases where this may not be considered absolutely necessary and economically feasible.

(ii) The Committee have appreciated the arguments advanced in the Report for the concentration of this heavy mechanical industry in one National Workshop situated in the coal mining area of Bihar-Bengal. They are of opinion, however, that both these aspects of concentration and location should be further examined by the Planning Commission. While the paramount consideration must be the national interest from the point of view of planned economy, existing plants producing heavy machinery should be encouraged to function where they can do so on an economic basis and advantageously to the nation. It should further be investigated how far the machinery required can be made, within the scheme of planned economy, in separate plants, situated in different parts of India. But in any event a major factory for producing heavy machinery etc., is necessary and should be started at a suitable centre. The location of such a factory should be decided

upon after considering all the relevant factors, such as availability of raw material and power, including hydro-electric power, climate, and possibility of enemy action. It should be further borne in mind that such plants for heavy machinery do not come into conflict with the small tools made by the village blacksmiths or other craftsmen, and thus throw considerable numbers of people in the villages out of employment. The objective aimed at should be to prevent the import into India of foreign machinery and other goods, as far as possible and economically desirable, and to fit this into the larger scheme of planned economy.

(iii) The Committee further agree and recommend strongly that the manufacture of automobiles and other articles and machinery placed in the light Mechanical group should be undertaken at an early date in India. Only one automobile factory appears to be possible under existing circumstances. The location of this should be fixed after further consideration.

(iv) The building up of the Electrical Industries as recommended in the Report is considered essential but their location may be decided upon later.

(v) All these industries being key industries, their ownership or control should, in accordance with the previous decisions of the National Planning Committee, rest with the State. The control in such cases should be adequate and effective. Existing plants during the period of transition, as well as small plants, may, however, remain in private hands, but all such plants will be subject to such control by the State as may be necessary in the interests of Planning. The State referred to is the national free State of India, and not a State controlled by foreign authority.

(vi) In the transitional period the State may encourage private capital to start such plants by guaranteeing interest for a period of years, imposing heavy duties on foreign articles and otherwise, provided always that the State exercises rigid control of all such undertakings in the interest of national planning. A system of licensing, as previously recommended by the National Planning Committee, is also recommended with this particular object in view.

(vii) Control of foreign companies and foreign vested interests by the State is essential for Planning and for the success of these enterprises.

QUESTIONNAIRE ON ENGINEERING INDUSTRIES ISSUED BY THE NATIONAL PLANNING COMMITTEE

(As given in Red Book I)

23. (P. 20) What are the chief mineral resources available in your Province? How far are these resources already being exploited, and developed, and by what agency?
24. (P. 20) What is the room for large-scale mineral, or metallurgical industries in your Province?
25. (P. 20) What is the policy of Government in your Province in regard to the grant of concession for the exploitation of mineral wealth in your Province?
26. (P. 20) Are there any Industries in your Province for the working up of the mineral raw material found in your Province in he shape of metal sheets and metalware of all kinds?

27. What agencies,—local, Indian, or non-Indian—exploit the mineral resources of your Province, under what form of organisation and on what scale of production?

28. What are the handicaps as regards the proper development of the various kinds of industries in your Province, relating to working up the raw materials into finished products of agriculture, forest, mines, animal resources, and "process" industries in regard to

(a) Capital,
(b) Skilled workers,
(c) Adequate labour supply,
(d) Marketing and other respects,
(e) Transport?

29. To what extent is capital, needed for such industrial development, available locally in your Province, or attracted from neighbouring provinces, or supplied from non-Indian sources?

30. What are the institutions concerned in the mobilisation, attraction and investment of local or foreign capital? To what extent do these institutions need to be varied improved or expanded, so as to supply adequately the capital needs of Agriculture, Industry, Commerce and other essential services to secure the **optimum** development of the Province all round?

31. What measures, if any, have been adopted in your Province to control the supply and regulate the conditions

of working of foreign capital invested in the industrial concerns operating in your Province?

32. How far is your Province adequately supplied in respect of skilled workmen, technical experience and general industrial or business enterprise and markets within and outside your Province? What steps are taken for making good the deficit, if any, of such requirement of industrial growth?

33. What policy or line of action has been adopted by you for attracting on suitable terms foreign technicians or experts in regard to particular industries? What conditions and restrictions, if any, would your Government desire to apply in regard to the importation of such foreign technicians, scientists, or experts?

34. What is the experience in your Province of the efficiency of available industrial Labour? To what extent do the conditions of work and employment of industrial Labour safeguard on the one hand the worker against undue exploitation and on the other, the community collectively against inefficiency in Labour?

35. How far, in your Province, are (a) the existing equipment in all large scale industries, and (b) the actual form of the organisation and management of such industries, sufficient to guarantee a fair degree of industrial efficiency in output, quality, etc?

36. What are the industries already in existence in your Province, which enjoy in one form or another, protection, aid or Provincial encouragement from the Central or Provincial Government in the shape of:

(a) Protective customs duty,
(b) Financial aid, e.g. a direct subsidy or bounty or guarantee of purchase of a minimum quantity of output at fixed prices,
(c) Cheap transport rates,
(d) Supply of useful commercial and technical information concerning such industry,
(e) Furnishing of skilled, technically trained experts to found and maintain such industries?

37. What agencies conduct such large industries in your Provinces—i.e. private enterprise, non-Indian, Indian indigenous to the Province, or from outside the province, or any public statutory body within the Province? How far is the development of industries under any of these agencies affected? How would you secure proper co-ordination of all these various agencies?

38. Are there any industries established in your Province conducted directly by foreign capital, recognised and registered in India as Joint Stock Companies, or affiliated to a nominally Indian concern, e.g. by adding the words "India Ltd".?

What steps would you suggest to prevent this growing menace of "India Ltd" and what remedies do you suggest and what effective steps you would advise us to take so that "Swadeshi Industries" as defined by the Congress may grow up in your Province?

39. Are there any industrial concerns in your province operating as part of an international combine regulating that industry or as mere offshoots if not branches of foreign industrial enterprise? What steps would you adopt to regulate and control the working of such concerns in the best interests of the Province? Would you suggest an All-India legislation on this point, and if so, on what lines?

40. Do you notice any tendency amongst the large-scale industries in your Province combining with corresponding establishments of the same industry within the Province, or within the country, so as to make a substantial monopoly of the industry in hands of that combine? What are the consequences in regard to prices to the consumer within the country, labour conditions, industrial equipment and technique, in regard to such industries?

91. What are the various available transport facilities within your Province which are:

(a) within the control of the Provincial Government,

(b) outside the control of the Provincial Government,

(c) within the control of local bodies within the Province?

92. How far are these existing means adequate for all the movement of men and goods in the Province?

93. What is the extent of road mileage, in respect of main trunk roads, provincial roads, and local by-ways in your Province? Has there been prepared any programme for increasing this mileage, and distributing throughout the province, that mileage in such a manner as to provide an efficient supply of road service throughout the province?

94. What are the handicaps in the way of increasing the road service within the province, and how does the Government of your Province contemplate, if at all, to remove such handicaps?

95. To what extent is your province interested in regard to water transport by river, coastwise, or overseas shipping, including building as well as operating ships?

96. What are the facilities for an efficient water transport service in your province? How far are they developed? What room is there for their further development?

97. How far is it possible to develop and increase these facilities by means of maintaining adequate channels, in the existing rivers, or making navigation canals from the rivers so as to interlink the river system; providing the necessary port and terminal facilities at central points on the rivers, and other such devices suited for the adequate development of cheap, efficient inland water transport within the province?

98. What is the extent of railway mileage in your Province of all gauges? Are there any supplementary tramways or light railways in your Province? How do the rates charged on the goods moved within the Province affect the development of Industry as well as market within the Province?

99. Are there any Railway Workshops or plant making establishment in your Province? To what extent do they provide employment for local labour, capital, skill and experience?

100. Have you had any occasion to make any representation on behalf of the Provincial or any commercial or industrial organization within the Province in regard to:

(a) policy and incidence of railway rates,
(b) employment in railway labour,
(c) development of outlying regions by means of cheap transport facilities. How far is there room for fostering such facilities in your Province?

101. What is the cost of transport, by road, rail or water on these various means or forms of transport in the province as compared to one another? How has the cost of transport affected the development of industries in your Province?

102. What means, agents, or organisations are there for controlling, in the public interest, the cost of transport or the rates, freights, fares, charged by the various agencies for the transport of the passengers and goods? How should these be developed if they are lacking at present?

103. What machinery would you provide to regulate as well as to secure speedy and effective settlement of dis-

putes in regard to the rates, freights and fares or charges for the transport service, its efficiency and safety?

104. Are there any industries in the province in relation to any of the means of transport, in the shape of the production and supply of the vehicles or their parts and accessories, including repairs; of the roads, bridges, including the material for the construction and maintenance of the roads, water-ways, rail-roads, tramways, ships and airway transport?

Are any ships built in your Province? If so, give clear idea as to the nature of the ships built and the extent of these building operations within your Province?

105. What are the raw materials, and other facilities, e.g., draught animals, available within the province to provide the basis for the establishment therein of any industry connected with transport within the Province as described in the previous question such as the production and supply of automobiles, ships, air-planes, rail-road wagons and locomotives, carts or wheels, and other parts and accessories for the same?

106. What are the handicaps in the way of establishing

(a) a ship-building industry in India sufficient to do all the water transport of goods or passengers on the rivers, along the coasts, of India, or in regard to overseas intercourse; and to supply a Navy for India,

(b) a locomotive and railway rolling stock making Industry,

(c) automobiles making industry, including all its parts, engines, accessories, as well as prompt and effective repair of the same,

(d) making and supply of aviation planes, airships, their parts, engines, and accessories?

What steps would you suggest for developing an Indian ship-building industry both for commercial and for defence purposes?

107. What scope is there for developing adequate industries for the manufacture and supply of the fuel, or motive power for the various means of transport within your province?

108. What facilities are available for repairing and "Servicing" or supplying of parts and accessories of transport within your province? How far is it possible to develop these facilities so as to make the entire business of transport safe, adequate, economical, and efficient in

working as a properly co-ordinated, rationalised, and modernised service for the entire province?

109. To what extent would the province be prepared to help to organise or participate in an all-India enterprise, which would supply the materials, parts, accessories, or complete vehicles for the organisation of the entire road, water, and air transport as an Industry as well as a service?

110. What are the industries dealing with the production of the means of communications already available in your province in regard to posts, telegraphs, telephones, radio and the like? To what extent is the manufacture and supply of the instruments, apparatus and accessories as well as their repairs necessary for these means of communication possible to establish and maintain within the province, or by means of a national central workshop for the manufacture and supply of all such instruments and appartus? How far and in what way would your province be able to contribute for starting and working such an enterprise if one were decided upon?

111. To what extent has the Government of your province associated themselves with any private enterprise in the interests of the general public, and for developing the industrial resources of the province including forests as well as mining, by means of cheap and efficient transport?

114. What are the agencies which today operate, or are in any way concerned with the various forms of transport within your province? How far is it possible to co-ordinate these various agencies into a collective or state-controlled enterprise, connected with the supply, or the transport service, or industries in connection with transportation vehicles, etc., so as to provide the most economical, efficient and co-ordinated service, for the transport of goods and passengers?

164. What would be the agency and the general policy under which you would recommend the establishment and development of industries relating to National Defence, including provision for Munitions and Armaments of all kinds for the use of the various defence services?

65. Do you realise that to introduce an economy in the productive capacity of the industries and to bring about a simplicity and efficiency in the use of the various articles, there should be a thorough standardisation of the types of goods manufactured?

66. Are you aware that there is no such independent but thoroughly representative, efficient and responsible body in India which should be in charge of standardisation for this country, although there exists such a body in every civilized country?

67. Are you also aware that the few standards that do exist here are but a copy of British standards and do not effectively serve the needs and demands of the country?

68. Do you not think that a body similar to the British Standards Institution be set up in this country with a thorough technical representation of the producers and consumers and other Scientists and Technicians and a procedure of setting up of standards be adopted similar to that of the British body? If not, what system do you propose?

69. Do you not think that an independent laboratory be maintained to check and evolve the various standards and work in general as a standardisation laboratory and testing laboratory?

70. (a) What do you say to making such necessary changes in the working, organisation and status of the government Test House so as to enable it to serve an independent standardisation laboratory instead of a minor establishment of the Indian Stores Department?

42. What steps have been taken or are proposed to be taken to ensure that the quality and flavour of these articles maintain during transport and storage? Is any scientific work being done in this direction?

62. Please give a comprehensive list of all such by-products or waste products and mention against each the quantity available, the various articles it can be made into and the consumption of such articles in the particular region.

158. Is it conducive to the interests of the entire nation, taken as a whole, that such a regulation or control of competition should not be undertaken at all? What attitude should be adopted that the future development of industries in this country should go towards fostering the national spirit rather than give rise to separatist tendencies and interprovincial rivalries? Do you think the provinces should be allowed to impose interprovincial custom duties?

163. Will you please give a list of such imported raw material and state the finished product which it will give rise to? How far has the separation of Burma affected the self-sufficiency of India as a manufacturing country?

How far will it be adviseable to work out some procasses by which it will be possible to eliminate altogether the use of such material and substitute in its place material available in this country?

94. Would you like to have the means of producing very cheap cement from say iron slag be investigated by scientific institutions (e.g. Industrial Research Bureau and Universalities) in order to bring about a great increase in the road mileage with the same funds?

152. What administrative organisation has been set up in your province to control, register, supervise, or in other way to foster and promote the industrial and commercial activities and the general economic life within the province?

How far have these organisations succeeded in achieving the ends for which they were set up?

How far has the failure been due to (i) the defective policy of the Governments concerned, (ii) the organisations being in charge of gentlemen administrations (e.g. members of the Civil Service, both provincial and Indian) rather than being in charge of scientists, industrialists or economists? What proposals you want to make for the reform of Industries Department?

153. What steps should be adopted to establish an All-India Industrial or Economic Council for the promotion of Control, Supervision, and regulation of all-India Industries, and the economic relations as between the States and Provinces arising out of the Programme of Planned development so as to maintain a uniform rate of even progress simultaneously on all fronts, avoid friction, and make the working of the Planned Programme, of local as well as National development effective?

If industries are to develop in this country, social welfare demands that they should be largely controlled from the consumer's point of view. This requires that industries would be under strict State control, and if this is to be properly done, Government should have a very

efficient civil service with a first-hand knowledge of and training in industry. Do you not think that the present system of recruitment of and training given to the civil service be modified so that they may have first hand knowledge of working of industries and thus may be better fitted to control the industries from the public point of view?

Should not the Industries Ministers have some sort of "brain trust" consisting of such Scientists, Economists and Industrialists who do not depend for their promotion or prospects in life on the favour of the Government?

17. What industries have been enjoying protection and bounties from the State?

18. What steps have been taken or are proposed to be taken and what percentage of their profit (which has accrued to them due to bounties and protection) have they spent or propose to spend on developing other important and Key industries which were closely connected with their industries? e.g. what steps have been taken by the Iron & Steel Industries to develop the metallurgy, casting technique and heat treatment of ferrous alloys which are the most vital processes in the manufacture of machines and tools and what steps have been taken by the Sugar industry in the utilisation of molasses, in the preparation of alcohol for use as fuel or in the preparation of acetic acid for use as an important ingredient in the manufacture of artificial silk and other chemical industries?

19. (a) What steps have the Government taken to impress on the industries enjoying such State help that they are assisted because they are vital to national interests and they must devote their time, energy and facilities in developing attached and allied vital industries and to see that it is done?

(b) If no steps have been taken up till now in this direction what do you think would be the best way of achieving this object?

20. What steps would you suggest to ensure a co-operation in this direction between the Government, industries, universities, technical institutes and engineering colleges?

Key Industries

21. Do you agree with the following definition of Key industries? If not, give your own definition.

"Key industries are those which aim at producing the means of production."

22. (P. 43) What do you say to the following list of Key industries? Would you like to amend it? If so, please give your amendment and the reasons for it. (The list Contains Power, Fuel, Metal, etc.)

24. (P. 43) How many and which industries should be started at once in this country and what pace would you set for them? Please draw a scheme as to the location of the industries, providing factories with the workmen, technical staff, raw material and the preliminary and fundamental tools and implements, the provision of organisation to help in the overcoming of difficulties arising in the course of production and to help in fixing the standards which the produced goods must conform to?

25. (P. 43) Even if it be thought that due to the hostility on the part of the Central Government or the British Government it will not be possible to start in right earnest any major key industries at once, do you not think that it would be advisable to start all the key industries on a small scale at once as it would help in the accumulation of technical experience and trained technicians?

26. (P. 43) For raising capital what objection do you think lies in the procedure adopted in collecting funds for Jubilee Celebration or some such activity? Why should not such a system be adopted for raising funds for starting Key industries in this country.

Supplementary Questionnaire

1. Has there been ever any attempt to manufacture in this country any of the following articles, at present imported?

2. What steps have the various departments of Industries taken from time to time to draw public attention to these items and have them manufactured here?

3. What are those industries which, although they were started here could not be carried on further and had to be subsequently closed down or are working at a great loss? Which of the following causes do you ascribe to the failure or imperfect working (both financially and technically(of each of the industries thus affected?

(a) Want of fluid capital
(b) Want of technical efficiency
(c) Policy of not employing properly trained technicians although they were available in the country.

(d) Inability to utilize the process to Indian raw materials.
(e) Inability to cope with the advances made in the line in foreign countries and with the changes in taste.
(f) Inability to avoid excessive waste as compared with other countries.
(g) Inability to utilize for other purposes the waste products of the industries.
(h) Location of the industries at a place far from the raw materials and the markets.
(i) Due to lack of sympathy on the part of the Government or failure to protect them against unfair foreign competition, i.e., absence of benificial legislation.

Quality of Products of Indian Industry

5. How do the products of Indian manufacture compare in their prices and other technical features with the imported goods? (Please give the information of as many products from the list (table 1) as you know. Do not reply to this question from a general view point illustrating by one or two industries).

6. How have these products been comparing with the imported goods ever since their manufacture in India?

Considerable development has taken place in regard to these industries because of the war needs, and also because of the normal growth of the country's industry. At least three important industries in this group have made a beginning, which though not all that it might or could have been, even in spite of the urge of war, has amply demonstrated the potentiality of India in this regard.

The Automobile Industry

The earliest in this group of industries to be conceived was in regard to the manufacture of motor cars, trucks, motor bicycles, and other vehicles of this kind in India. A carefully prepared project had been in the air and was taken up, even before the declaration of the war, by an enterprising concern of Constructional Engineers in the country in 1938. It sought to secure the co-operation of an outstanding Automobile Concern in the United States. The latter agreed to provide engines and other parts of such vehicles, to be assembled in India, in the first instance, up to the then average imports of such vehicles in the country, namely 15,000 units. It was hoped that within five years this beginning in the shape of an Assembly Plant in India would grow into a full fledged Manufacturing Plant. The Agreement with the American Concern provided that every year 3,000 units of their make would be made in this country, so that within the specified period of five years the then estimated average import of such articles would be made wholly from indigenous resources of the country. Every year during this period the balance of the average import of 15,000 units, not made in India, the American makers would be free to import into this country. It was also agreed to share all Patents, the American concern placing all their existing dies, patents etc., at the disposal of the Indian Concern.

The Government of India, however, did not look with favour upon this venture and so they would not offer even the most modest encouragement requested, viz., a promise to purchase all the standard trucks turned out by this enterprise for use in their Army or for Civil needs. The Government of Bombay on the other hand, were more sympathetic and had promised their support to maximum possible under the Act of 1935. The Congress Government, how-

ever, leaving Office soon after the declaration of War in Europe, those proposals also had to be scrapped.

An alternative arrangement was made by the Indian concern with the Government of Mysore. In the beginning of 1940-41, a concrete scheme seemed almost ready for execution, when a concatenation of political developments in that State, in which the Government of India are believed to have no small share, culminated in the removal of the then Prime Minister of Mysore from his place; and so once more the project had to be shelved. Several other financiers and industrialists have, since that time taken up the idea of producing vehicles in India with the aid of British or American corporations. Agreements similar to that mentioned above have been made with other American or British Firms to enable India to build her own Automobile vehicles of various types. Funds have been oversubscribed for them; but the industry has not yet begun active operations. There are some who question the possibility of commercial success of that industry in this country, because of the inevitably small size of the operations, which, in the aggregate, cannot be expected to produce more than 20,000 or 30,000 units per year,—a number produced by a single concern in a week in America,—and the consequent inability to reap the benefits of a large-scale industry in this highly specialised one.

With a sympathetic national Government, however, this handicap may be easily removed, particularly if full advantage is taken of the relative cheapness of Indian Labour, and the raw materials for all parts available in the country. Even in this regard, however, recent trends have brought about such a rise in prices and wages, that the original advantage the Indian Producer seemed to possess over his American or British competitor is more than counterbalanced. The establishment of several competing concerns, each with a different co-adjudicator in the United States or in England for the making of up-to-date automobile vehicles in India, including their engines and all spare parts, threatens intense internal competition which may quite possibly endanger the prospect of these concerns without properly establishing the industry which they have all ventured into.

The need to have this industry in the country, owned, controlled and managed by its nationals, is undeniable for India's success in industrialisation, everyday requirements and demands in time of war. It would be legitimate to

expect that the Defence Service needs of this country in regard to Automobiles of all types, and mechanisation in all branches of that service, should be met exclusively from indigenous sources as far as possible; and that if these sources are still undeveloped, they must be developed as soon as possible. The only solution under these circumstances seems to be for the Government to take up the enterprise as a national monopoly, the more so as there are no vested interests in that field to demand compensation, and also because of the declared policy of Government, following the Resolution of the Indian National Congress at Karachi in 1931, to own, conduct and control such "Key" industries as collective enterprise of the State in India. Wiser by the happenings of the war, the National Government have already announced a similar policy in two other branches of the Transport Industry, namely Ship-building or Shipping and Aviation. With such precedents or declarations of policy, therefore, it is not too much to hope that a National Automobile Industry, sufficient to provide all our needs of such vehicles in peace and war will be established in this country as a collective venture and a National Monopoly, avoiding all the dangers of wasteful, avoidable internal cut-throat competition; and at the same time guaranteeing the country an essential item of national defence as well as of all-round public utility needed for industrialisation.

Shipping and Ship-building

More or less a similar history is to be found in another branch of the Transport Industry, namely Shipping or Ship-building. Whatever the past history of India's ships, shipping and ship-building, in bygone centuries, since the advent of the iron steamer, Indian shipping had fallen very much into desuetude; and almost the whole of the shipping business of the country fell into foreign hands where it became almost a monopoly. Such ships as plied along the coast of this country and carried her commerce to and fro, over the high seas, were foreign owned or foreign managed and exacted an invisible tribute. It took half a century for Indians to realise the nature and consequences of this unseen drain in its full proportions. World War No. I demonstrated the need of shipping enterprise, owned and operated by Indians, even if ships of the modern type and tonnage could not be built in the country itself.

Soon after the close of that war in November 1918, an Indian Concern was formed, beginning with an old steamer

which had been used during the War as hospital ship for service in the Indian Ocean or the Arabian Sea. The moment, however, the Indian enterprise entered the field, a relentless opposition was declared by its British competitors even along the coast of India. It had been an accepted principle of national policy in most countries, with Britain leading, that the shipping service along the coast of a country should at least be reserved for its own nationals. This, however, was denied to India so far as Indian-owned ships were concerned. The result was that the establishment of a Mercantile Marine, owned, manned, controlled and managed by Indians, became an article of faith with the most popular political party in the country. A Mercantile Marine Committee appointed by the Government of India had recommended encouragement to Indian Shipping. The one Indian Concern which had resisted at considerable sacrifice the competition of British vested interests in the Indian waters, was forced after five years of hard struggle to make an agreement to share some of the coastal trade on a very modest basis.

This helped the company to survive, so to say, when it was on the verge of extinction; and enabled it to put up a stiffer and stiffer fight till at last the principle of coastal reservation had to be accepted. Effect, however, was not given to this principle all through the British Regime in India, which ended on August 15th 1947.

During World War II, however, the need for India's own shipping was even more acute than in the previous War. The shipping, which was Indian-owned, managed and controlled, and which was then in existence, was fully utilised by Government in their hour of need. Mere Indian owning of ships was however not enough. The War showed to an unquestionable degree the need of the country possessing her own ship-building industry, not only for repairs of damaged vessels, both of the Navy and Mercantile Marine, whether by the hazards of War or of nature; but also for complete construction from Indian materials as well as workmen. A Ship building Yard was, accordingly, proposed to be set up at a suitable Port on the East Coast of India namely Vizagapatam. The out-break of the War, however, made the progress of that new industry much lower than it should have been, partly because of the lack of the still persisting step-motherly attitude of the Government of India, partly because of lack of parts and materials which could not be made here at the time.

A further obstacle was caused also by active hostilities beginning on the coasts of India herself. At one time danger of bombing by Japan of the Ship-Yard was so great, that the entire Plant and Machinery had to be removed, at a very considerable cost of transport, to Bombay. Since the War, however, the Plant, etc. have been retransferred to the original site, where ships are now being built of 8,000 tons each, which it is hoped will be ready to take the water within a couple of years at most. This, however, is only a beginning. India has at present (end of 1947), hardly about 1,50,000 tons of shipping,—owned, controlled and managed by her own nationals. But all this shipping is almost entirely of foreign make. Given the length of her coast line, the size of her trade, both coastal and overseas, and the number of passengers carried, this tonnage can scarcely be called adequate to do even a fraction of what may be called the legitimate share of India in her own trade.

It has been computed by a competent Committee that the minimum need of this country, in regard to shipping, would be something like two million tons, if she was to get her legitimate share. This, however, cannot be built within any short space of time in this country. The only alternative, therefore, is to acquire such ships from abroad. With the heavy destruction that shipping met with during the course of the War, the pre-war leaders in the business are themselves very much in need of every ton they can build or buy. The only country which seems to have a surplus in shipping tonnage is the United States, where, however, India finds serious difficulties in acquiring any part of her much needed tonnage. Technical objections due to the make of Liberty and Victory Ships apart, there is the handicap of the scarcity of Dollar Exchange, without which such shipping cannot be acquired. Government have, no doubt, done what they could to facilitate such acquisition. But the intense competition of almost every country in the only market for acquiring such ships has raised prices so high, and caused so many other difficulties that private enterprise may well despair of reaching the optimum figure mentioned above.

Government have, accordingly, declared their policy to take an active hand in providing the necessary amount of shipping tonnage, to be owned, manned, controlled and managed by India. Efforts to come to an amicable settlement with British Shipowners having failed, a responsible Minister of the present Government of India declared at a Conference in Bombay, held in November 1947, that Gov-

ernment intended to start two or three Statutory Shipping Corporations, in which they would themselves hold at least 51% of all capital required. The balance of such capital would be open to be subscribed by the existing Indian Shipping Companies or groups of them.

These Corporations would be, presumably, assigned separate sections of the Indian Coastal and Overseas Trade, in goods and passengers, so that there need be no competition between them. The existing concerns, which co-operate with Government in this scheme, provide the balance of the capital, and possess some experience in regard to the management of the coastal and foreign shipping business of these dimensions, will be used as Agents to manage the Corporations on behalf of the State. In the event of any portion of the capital not being subscribed by the existing Concerns, public subscriptions would be invited to make up the entire capital, and run the concern as a State enterprice. Whether or not any capital is provided by an existing concern, Government will also require a proportionate share on the Board of Directors of each such Statutory Corporation, and also have an effective voice in the day to day management of such a concern.

This programme promises to be realised more easily than if individual private concerns were left to their own devices to acquire the necessary shipping, and operate the business on a competitive basis along the coasts as well as overseas. This arrangement falls, no doubt, short of a complete nationalisation of a vital Public Service. But given the existence of powerful vested interests in the field; given also the lack of technical skill and experience in management of such an enterprise in the ordinary civil servant, the device of Government going into partnership with existing concerns seems a good compromise to build up an overdue service. It would be all the more acceptable, if, in the formal agreement, Government reserve to themselves the right to buy out, after a stated period, the share of the private concern; and, as in the case of the Guaranteed Railway companies, run the business enitrely as a State Concern.

AVIATION

In Aviation, also, the same history is repeated, and the same short-sighted policy maintained both in regard to the Air Transport Service, as well as building up a suitably-sized Aircraft Factory. An Indian Air Transport Service was in existence for some years before the War, which has

sinec been extended into seveal regular lines linking up the principal towns in India. A fairly well considered system of licensing the Service through the Civil Aviation Board has been adopted, mainly from the point of view of ensuring safety of passengers, efficiency of the aircraft, and avoidance of internal competition. The extension of that Service to cover the entire country and all its towns, with interlinking and transfer facilities, to carry all inland mails, and develop an adequate Overseas Service through Indian owned and Indian managed Airways, still remains to be achieved.

As in the case of Shipping, the Air Service is run by planes bought readymade, either from the war-time surplus stocks,—which are converted to suit civilian demands,—or post-war production for longer journeys. Given the climatic conditions of this country and its relative freedom from fog and rain for the greater portion of the year; given also the development of safety devices like Radar, India promises to be a very good field for aviation development. Government have declared also their policy of setting up some Overseas International Airways Corporations of their own, to acquire for India her just share in Overseas transport by air.

Such foreign-made planes, however, make India depend exclusively, as in the case of Railways and Shipping before it, upon foreign supplies, which may at any time be cut off because of a war or any similar contingencies. India must, therefore, have an Aircraft Making Enterprise of her own if she desires to develop this Service and Industry to its legitimate natural proportions in this country.

Early in the War, the Hindustan Aircraft Factory was founded as a joint venture of the Indian and Mysore Governments, which was managed by a private Construction Company, being an equal partner in the Enterprise. Its capacity, however, was very limited, being able to produce not more than 12 Aircraft a year. This was too small to meet the war demands of the Government of India which ran into hundreds of planes of a variety of designs annually. The factory, however, was useful in forming nucleus and providing an excellent Workshop for carrying out repairs and replacements, needed because of the War, and also in peace. The private partner in the venture was bought out in 1942, at the instance of the American Lease-Lend Administration, which did not like any private concern making a profit out of the Aircraft demand created by the international emergency. Americans refused to supply spare

parts, technical advice, and other facilities needed to running the Bangalore Factory, so long as any private partner remained in the concern. The latter was accordingly bought out; and the Hindustan Aircraft Corporation is now a joint venture of the Mysore and Indian Government, the latter owning 2/3rds of the capital invested. It would need to be considerably expanded, if the Factory is to serve its real purpose in providing up-to-date repairs and replacements to the air-craft used both in peace and war; and building new ones of all kinds for civil and military requirements.

RAILWAYS

The oldest industry in connection with the Transport Services in this country is the Railways first established over a hundred years ago. For a long time after the coming of the Railway in India, there was no production of the parts necessary for operating a railway. Neither locomotives, nor coaches or waggons, neither their springs, fittings, bolts or nuts were made in this country though every year the demand went on growing. Even the Rails were for many years imported. The growing consciousness of the Indian people, however, of this great hiatus in an essential Public Service and the desire to meet the most elementary needs of that enterprise from indigenous sources led them to begin with an Iron and Steel Industry, of which fuller note is taken hereafter. When that industry had developed sufficiently, the making of certain parts, of locomotives and waggons, coaches and carriages, their fittings and furniture could no longer be denied if the country was to be self-sufficient in regard to a vital service of public utility.

So long as Railways were managed by Companies, this desideratum could not be attained, as the leading Companies were foreign owned and alien managed. Even when the Railways began to be acquired by Government, and conducted as Public Enterprise, from about 1925, the basic policy remained unchanged. It showed itself at its worst in 1936-37, when a proposal in the Legislative Assembly to establish a Locomotive Production Enterprise, was turned down by Government on spurious excuses and unconvincing arguments. A private concern formed soon after World War I for the manufacture of locomotives and waggons in this country had failed mainly because of the ruthless competition of foreign makers.

World War II however, emphasized the need of self-sufficiency in this as in all other respects; and so the Indian

Government had perforce to change their policy in 1943. An Indian Enterprise in the Iron and Steel Industry was associated with Government in a Locomotive Building Workshop established in the country. There is considerable room for expansion of this enterprise; but the pre-occupation of the present Government of India in other fields has made it unable to attend to all these vital needs immediately. It is to be hoped that this would form an integral part of the National Plan when one comes to be at last made and put into execution.

THE IRON & STEEL INDUSTRY

The basic Industry in all these matters is the Iron and Steel Industry. India was famed in ages past for her iron ware, and steel goods. Such momentoes as the Delhi Iron Pillar are probably not more than 1,500 years old; but the swords and arrow tips made centuries before that date were famed in history even as far back as the days of Herodotus. The size and quality of that ancient Industry can only be inferred from such survivals as the Delhi or Dhar Iron Pillar. Competent students have recorded the impossibility for any European foundry or workshop, to have produced such articles, until the invention of the Bessemer process. Such as that Industry was in the days of India's glory, it completely died out in the last 150 years, ever since British products began to compete with Indian made goods and oust them from India's own market. It was only at the beginning of the present century that an enterprising industrialist, the late Mr. J. N. Tata, started this industry anew, notwithstanding the enormous initial outlay and many great disappointments before it could be on its legs. As in the case of other ventures, the Indian Government was from the start hostile to this industry. The only encouragement it would give was confined to a promise to buy 20,000 tons of rails every year from this concern on competitive terms. It was only after World War I, which made the necessity of an indigenous source of supply too obvious to be doubted, that some protection in the form of fiscal duties was afforded, after a pitched battle in the Legislaative Assembly on the report of the special Tariff Board which had recommended such measures.

It would take us too much out of our way to give, however briefly, an outline of the viscissitudes this industry has had to undergo.

There is, indeed, no lack of raw material for this industry in this country. Several factors, however, prevented

successful development until the World Depression of 1930, when the Indian Industry may be said to have reached its nadir. Grant of substantial tariff protection aided by increasing home demand stepped up rapidly in the War, brought prosperity to this industry, which, however, would be once more threatened, if international competition begins to swamp the Indian Market, and the Indian industry remains unprotected.

This period has brought good expansion to the industry, accompanied by improvements in the various processes, and increasing application of more and more scientific methods. The successful development on a commercial scale of the rapid Dephosferising Process, and the making of acid steel out of Indian pig iron, may be regarded as the most important advance in steel-making practice that the Indian Industry has achieved.

Several new Industries to make other products from this basic material may well be expected to be born of this advance. One of the most important of these is the manufacture of railway wheels, tyres and axles, for which acid steel is indispensable. The Indian Iron & Steel Industry has recently added the necessary plant at Jamshedpur for making these articles and furnishing requirements. The development and manufacture of a low alloy high tensile steel containing copper and chromium is another similar development, which enables the steel produced in this enterprise to be used for some of the biggest bridge constructions in this country. The industry has also aided and encouraged not only research in its own immediate raw materials, but also in regard to fuel, chemical research and research in refractories. Amongst the special steels they now produce in India are special bars for the manufacture of shells, bullet-proof armour plate for the fabrication of armoured vehicle bodies, similar plates for howitzer shields and gun turrets, various kinds of alloy steels for the manufacture of steel helmets, armour piercing bullets, and shots; and shear blades for shearing armour plates, chrome molybdenum alloy steel for arcraft, spring steels for machine-guns, special deep drawing for machine gun mazagine, nickel steel plates for gun carriage mountings, high carbon steels for high explosive shells and mint dies, high speed steel for machine tools and stainless steel for surgical instruments. Yet another line of new steel production includes steel mill rolls, steel billets for drawing into telegraph wires and barbed wire, and steel according to Admiralty specification for ship-building. A process for the manufac-

ture of acid open hearth steel, required for gun forgings, gun carriage axles and railway wheels, tyres, etc. has also been developed. Arrangements have also been made for developing the Locomotive Plant in association with the largest steel enterprise in the country.

The basis of all Engineering Industries is to be found in iron and steel or metals which may take the place of iron and steel. The Planning and Development Department of the Government of India has appointed a Panel which dealt with Iron and Steel Industries and made the following recommendations:

246. **Current Production.**—The present production of finished steel of all classes including that produced in the Ordnance Factories and in electric and other small furnaces and steel rolled from scrap cannot be estimated at more than about 1,200,000 tons per annum. When the Steel Corporation's Duplex Plant comes fully into operation, about 200,000, tons will have been added to this quantity. A surplus of about 150,000 tons of pig iron over and above what may be used in the manufacture of steel may be left for castings and other iron products.

247. **First Post-War Target.**—If we were to estimate the future on the pre-war demand for iron and steel, except perhaps in the case of iron castings, the above quantity may be just adequate for our requirements. Such an estimate will be, in our opinion misleading. The erection of a new complete iron and steel plant of an economic size will take at least five years under reasonably favourable conditions. Another two years will probably elapse before it approximates its rated output. We have, therefore, to look at least seven years ahead and make an estimate of the probable demand at the end of that period. For this purpose we must take into account the estimates given by such of the principal consuming departments of the Government of India who have been in a position to do so and the Provincial Governments in relation to their post-war development plans. We must also make allowances for the demand which cannot be assessed in terms of tonnages at present, but is potential and likely to arise. We believe that on this basis India will be in a position to absorb an extra tonnage of a million to a million and a half of iron and steel at the end of a period of seven years from now and that the Government's target of increasing their output to 2½ to 3 million tons is both feasible and desirable. We would like to emphasise that realisation of the target

is largely to depend on the materialisation of some at least of the many major schemes now under investigation. In this view we have the unanimous support of all the principal Chambers of Commerce both Indian and European.

248. In so far as our estimate may be realised there is likely to be a shortage of iron and steel before any new works is built and is in production. This may be partly met by—

(a) The completion of the Tata Iron & Steel Company Ltd.'s short term programme of adding 150,000 tons to their present output;

(b) Mysore Iron & Steel Works extending its production by about 30,000 tons in accordance with its plan;

(c) The Ishapore Ordnance Factory contributing 60,000 to 70,000 tons with the addition of two more furnaces and producing basic instead of acid steel for the time being. The addition may cost 15 to 16 lakhs which, if Government do not provide, may be found by the Selling Organisation;

(d) The Steel Corporation of Bengal undertaking and carrying out a scheme of expansion of another 200,000 to 300,000 tons of finished steel.

249. **New Plants to Achieve Target.**—The* smallest economic, unit for the production of iron and steel under modern conditions would have an initial capacity of not less than 500,000 tons of ingot and 400,000 tons of finished steel and so designed that the ultimate capacity can be approximately doubled. Even if the existing steel producers undertake to increase their output in the next five years by 500,000 tons it is desirable to establish a new unit immediately with an initial capacity of 500,000 tons and an ultimate capacity of a million tons of ingot steel per annum. If the demand keeps pace with our estimate, then it is desirable to set up a second steel works of similar capacity.

* It may be noted that even today, (January, 1948) there is no sufficient industry in this country for making Nuts and Bolts of various gauges needed for all kinds of machine tools. For the latter at least one company, The Investa Machine Tools Corporation is already working; but is handicapped for want of such articles, as basic material. No private capitalist concern would put up the necessary plant and machinery needed for making such Bolts and Nuts, as the demand is very small, and so it would not be worth their while to lock up capital which such machinery producing on a large scale would necessitate. It must, therefere, be impressed upon the Planning Authority to see to it that due place is given to such primary requirements, even though they may not be imposing in appearance

250. **Regionalisation.**—Every ton of finished steel requires the transport of five tons of raw materials. Owing to the narrow geographical limits within which the existence of the principal raw materials is confined and the necessity of erecting large units for the purpose of producing the cheapest iron and steel, the regionalisation of this industry in its primary form is neither feasible nor is in the public interest. But the regionalisation of steel processing and consuming industries is not only possible but desirable. Such industries will include some Re-Rolling Mills which will be dealt with in our Second Report and mechanised plants for the manufacture of all descriptions of agricultural appliances and implements, cans and containers, furniture, window frames, household appliances bolts, screws, nuts etc. Among larger industries are structural Engineering, Housing, Shipbuilding, manufacture of Heavy Machinery, Motor Cars, River Craft, Armament and Equipment for the Armed Forces. If a Continuous Plate and Strip Mill is established, even relatively small units for the manufacture of sheets and tin-plates are economically possible in the larger centres of consumption. These are but a few instances where regionalisation is practicable.

251. **Location of New Plants.**—If the target is to be realised in the shortest possible time, the new plants can be located only in those Provinces where sites fulfilling the following among other conditions are available:

(i) Possession of an abundant and perennial supply of water. It is estimated that a plant of the type indicated above will require about 200 million gallons per day for circulation and about ten million for daily make up on an average in addition to about five million gallons for town use per day. The requirements may be larger if any subsidiary or auxiliary industries particularly chemical are established in the immediate neighbourhood.

(ii) Proximity to the sources of supply, already worked or easily workable, if the principal raw materials, particularly metallurgical coal, iron ore of good quality as free from impurities as possible, lime stone suitable for fluxing and various refractory materials. The quality of these materials should have been previously proved on a commercial basis and not merely deducible from the reports of geologists, as the period within which the works are intended to be built is too short both for ex-

periments on a large scale as to their serviceability on a commercial scale and feasibility of their immediate exploitation.

(iii) Good communications especially by existing railway systems without involving any considerable main line extensions and consequential delay both for the transportation of raw materials and the distribution of the finished products.

252. We have carefully studied all the data presented to us by the principal Provincial Governments and Indian States where the existence of most of the raw materials has been claimed on the surveys and reports of geologists and other experts. But except Bihar and Western Bengal, there is no part of India where a major iron and steel works can be built and brought into operation within the period we are considering, except perhaps the Central Province which appears to have the best immediate claim to the establishment of one such works. In this Province a site at or near Tilda between Raipur and Bilaspur substantially fulfils most of the above conditions except that at present no workable deposits of metallurgical coal have been discovered, much less worked. Until an intensive geological research has brought to light workable deposits or metallurgical research has made possible the coking of such grades of coal as are being or can be economically worked, coke or coking coal may have to be brought from Bihar or West Bengal, a distance of about 400 miles. Having regard to the excellent main line communications which already exist and the availability of other raw materials, we believe that the transport of coke or coal over this distance will present no insuperable economic or technical difficulties. Moreover, the site now recommended in this Province may prove to be a more convenient centre for distribution to the whole of the Peninsula and considerable regions to the west and north than any site in Bihar or Bengal. Accordingly, we recommend the erection of one of the works in the Central Province and another one in Bihar on or near the South Bank of the Ganges near Jamalpur when circumstances justify its erection, as already explained by us, as part of the first five year programme of post-war development.

253. The sites recommended by us are not to be regarded as more than worthy of consideration during the preparation of concrete projects. The actual selection must rest with the promoters of the schemes and their technical advisers.

254. **Cost of an Erected Plant.**—In the present uncertain conditions governing both foreign and domestic prices it is not possible to make a precise estimate of the cost of an erected plant. Upon such fairly reliable materials as we have been able to collect, a plant erected in India before the war with an initial capacity of about 400,000 tons of finished steel and so laid out and designed as to permit its further expansion to double this capacity would have cost 12 to 13 crores of rupees. This cost excludes collieries, ore-mines, working capital, financial charges prior to the commencement of operations and starting expenses.

255. Judging by the prices prevalent abroad, particularly in the United Kingdom in 1945, it will be unsafe to assume a lower increase in the cost of such a plant than that of 70 to 80 per cent. The cost will vary with the kind of products to be rolled. A plant for the manufacture of medium and light sections, merchant products, rods, hoops and bars will cost about 22 crores, while a plant with a continuous plate and strip mill about 25 crores excluding the charges mentioned in paragraph 254.

256. The choice of the products to be manufactured and the type of equipment must be left to the promoters and their technical advisers. But any scheme which may be decided on should be prepared in close consultation with the existing industry in order to avoid unnecessary duplication or overlapping.

257. **Railway Freights.**—We are in no position to consider whether Railway freights generally are so high as to impede or discourage the industrialisation of the country. But we are satisfied that if freights, the prices of metallurgical coal and the wages of labour continue to show a simultaneous rise, India may before long be deprived of the advantages which have enabled it to produce the cheapest iron and steel in the world.

258. As palliatives and not as remedies we suggest the following:—

(i) If it is a fact, as we understand it to be at present, that the minimum freight rates on the Railways are based on one way traffic without taking into account the return traffic on part or whole of the system on which it is carried, then in the event of a new steel works being established in a locality from which ore can be brought in the same wagon in which coal has been brought to that locality, that factor should be taken into account in fixing the rates of freight applicable to the total traffic.

(ii) A distinction be made between coal for blast furnace despatched to iron and steel works and coal used for other purposes. Appreciably lower freights should be charged on the former than on the latter.

(iii) If the iron and steel industry is controlled especially with reference to prices, there is a strong case for the control of the prices of Blast Furnace coal.

(iv) Every possible measure should be taken to prevent the use of such coal for other than metallurgical purposes by Railways and other consumers. One method of partially achieving this object will be the levy of such high freights on such coal as to make its use for non-metallurgical purposes wholly uneconomic.

(v) In order to prevent the concentration of processing industries in certain areas, the freights on pig iron and semi-finished steel should be substantially below those payable on finished steel.

259. **Incidence of freights.**—It is not possible in a vast country like India so to distribute iron and steel as to even out completely the prices for consumers irrespective of their distance from the main centres of production. But if the consumption of iron and steel is to be developed, it is necessary to mitigate some of the disadvantages from which the distant markets such as those in the Punjab, the United Provinces, South India, etc. have suffered.

260. For this purpose, we suggest the following changes in the future price structure of iron and steel:—

(a) The products should be sold at a price ex-works plus the freight from the works to destination and not as hitherto from the nearest port to destination.

(b) No consumer should be made to pay a higher freight than a reasonable minimum such as about Rs. 30 or so per ton.

(c) No consumer should be wholly free from the liability to pay freight, as has normally been the case at the main ports.

(d) No consumer should be wholly deprived of his geographical advantage in relation to the centre of production.

261. Such a price structure will involve some sacrifice from those who have been more fortunate than others in the past, but they will be in the long run compensated, if by promoting the use of iron and steel it is possible for the industry to reduce the costs and with them the prices.

262. **Control of the Industry.**—As the Government of India themselves have declared, it is impossible in a planned economy to do without controls and some circumstances exist in this industry which apart from this general consideration make their introduction in some form desirable in the general interest. The main directions in which such controls may be required are as follows :—

(a) Regulations and stabilisation, as far as it may be practicable, of the prices of iron and steel which have progressively risen and have been liable to frequent changes during the last 12 years or more.

(b) On a long view, it will be in the interest of the industry and of the consumer, if these prices are not related to foreign prices but based on the domestic works costs, to which should be added inter alia—

(i) a liberal percentage for depreciation and all usual overheads;

(ii) a rate of profit, which on the one hand would maintain the existing industry in a healthy and financially sound position and on the other would attract the amount of capital which would be required for its rapid development;

(iii) all direct and indirect charges for sale and distribution which cannot directly be recovered from the consumer; and

(iv) an adequate margin to stabilise prices at levels which will not necessitate frequent alterations.

(c) In order that the domestic price structure may not be disturbed by foreign prices, imports of iron and steel should be prohibited except under a license duly issued for the purpose.

(d) To prevent an artificial shortage of iron and steel in order to take advantage of higher prices in the export markets, exports should likewise be forbidden except under a licence.

(e) As a safeguard against uneconomic over production or the development of the industry on wrong lines the construction of new units of production should be permitted only under licence.

263. **Selling Organisation.**—The creation of a Selling Organisation which includes all the primary producers, both existing and future and some representation of so much of the Re-Rolling industry as is reorganised and ful-

fils the conditions laid down by us should be charged with the performance of the following duties inter alia—

(a) Sales and distribution of all iron and rolled steel products, produced in whatever form and of whatever quality including scrap and defectives which have a saleable value at prices fixed with the approval of the Government.

(b) To import from the most favourable source such quantities of iron and steel as may be necessary to meet the demand for them in time to prevent any shortage of supply.

(c) To develop an export market in those areas where geographical or economic conditions are most favourable, if and when local production is in excess of local requirements.

(d) To maintain a good standard of quality for all iron and steel both at home and abroad.

264. **Methods of Control (proper).**—It is suggested that any control, the general nature of which is indicated above and which in the interest of the public may be considered desirable to introduce, should not in the first instance be exercised by the Government itself. The major iron and steel industry to-day consists of three primary producers, viz. The Tata Iron & Steel Co. Ltd., the Steel Corporation of Bengal (working in conjunction with the Indian Iron & Steel Co., Ltd.) and the Mysore Iron and Steel Works. The experience, status and management of these organisations justify our confidence in their ability and willingness to prepare and submit for Government's approval a scheme under which they form a Selling Organisation somewhat on the lines of the Tata-Scob Agreement, fix prices and agree to undertake and perform those and other functions, obligations and duties mentioned above, which otherwise may be imposed on them or performed by Government itself. If no such scheme is prepared and approved by the Government, there may be no other alternative than direct Government control including sale and distribution of iron and steel at prices fixed by the Government after such enquiry as may be deemed necessary for the purpose.

265. If the Industry organises itself and prepares a scheme acceptable to Government, the control should take a simple form and include inter alia—

(i) An authority to issue licences for (a) exports, (b) imports, and (c) construction of new or the expansion of existing units of production.

(ii) Submission to the Government of such information as it may require relating to the profits made, the dividends paid, the amount of depreciation set aside, and any other particulars with reference to the activities and operations of the industry as may be prescribed.

(iii) Publication of the schedule of prices and variations in them.

(iv) Provision for an inquiry when the Government deems necessary or at such intervals as may be prescribed into its operations, activities, efficiency and expansion.

(v) The appointment of an authority for enquiring into and reporting to the Government on legitimate complaints against favouritism, excessive prices or other activities injurious to public interest.

(vi) The maintenance of a statistical department with authority to compel the production of figures including those relating to prices in such form as may be prescribed in consultation with the Selling Organisation. Such statistics as are of interest to the public should be printed, published and put on sale to the public.

266. **Protection.**—The following modification of Government policy is suggested viz:—

(a) The primary producers of iron and steel have dispensed with protection and the need for the continuation of the protective duties does not exist. But foreign competition, though it may remain dormant for some time, may revive at any moment. The Protective duties, therefore, should remain on the Statute Book but their levy should be suspended until such time as their imposition again becomes necessary and in the meanwhile the industry should be declared a protected one. This is necessary both in the interest of the existing industry and for the purpose of attracting into it necessary capital for expansion.

(b) The excise duty should be abrogated at the first possible moment.

(c) The heavy burden of taxation, particularly that of the high rates of income-tax and surcharges, which has a crippling effect on industry, should be alleviated to the maximum degree possible.

(d) The "Equalisation Fund" and all surcharge at present made by the Iron & Steel Control should be abolished.

267. **Private Capital.**—We believe that the necessary capital to finance the projects suggested will be forthcoming, provided

(a) the industry is declared a protected one though the levy of existing duties may be suspended until their reimposition again becomes necessary by reason of foreign imports re-entering the country at prices below those considered fair for the industry;

(b) though the conditions are not at present predictable which may necessitate the grant or continuance of protection when the new plants begin to function, some assurances on the followng lines are given:

(i) That such assistance will be accorded in such form as may be necessary to enable the new works to realise a selling price, which would include all the usual works costs plus a reasonable amount of depreciation and a return of investment, which at the time may appear to be consistent with the development of the works and the expansion of the industry;

(ii) Purchase or guarantee of principal and interest on debentures equal to about 1/3 of the capital; and

(iii) In fixing the selling price regard will be had to the disparity which may exist at the beginning between the works costs of the older works and the new works and also their varying investment per ton of output. It is not easy to suggest what form this should take, nor is it necessary as long as the Government make it clear that this factor will be taken into account.

(c) Public confidence is not shaken in the prospects of the industry by an immediate, sudden or precipitate reduction in the selling prices of iron and steel products.

268. If, in spite of the Government giving all the assurances suggested by us, no private capital is forthcoming, the Government themselves must immediately undertake the projects outlined by us, for, a key industry such as this on which the whole industrial structure of India is to be built cannot wait on private capital or enterprise, if it is not sufficiently interested in the development of the country to subordinate the profit motive to the country's general welfare.

269. This industry is of such vital importance that it should be treated by itself, if conflict of provincial or other

interests delays the examination and co-ordination of all the schemes forming part of the 15-Year Plan.

270. Having decided on the immediate expansion of the industry, we recommend the following further measures to be adopted by the Government to expedite the fruition of the projects, viz:—

(i) to secure priority for the requisite finance and foreign exchange, importation from overseas of the plant, machinery and equipment including shipping facilities;
(ii) to arrange for the supply of all necessary raw materials for constructon of the plant, buildings etc. and also for the manufacture of the auxiliary raw materials required in the processes of manufacture;
(iii) to ensure the supply of coking coal;
(iv) to arrange for the necessary transport facilities;
(v) to revise the Railway freight structure in relation to this industry;
(vi) to arrange for securing the services of competent Consulting Engineers with knowledge and experience of the latest developments in the technique, processes and equipment of this industry in the most advanced countries; and
(vii) to arrange in advance for the technical training of qualified young Indians both in factories of the makers of the plant and in the most up-to-date iron and steel works in foreign countries.

271. **Price Control.**—Before any effective action is taken to reduce the selling prices, the Government should undertake an examination of the causes which may have contributed to their rise, whether they were due to Government's own action or to other circumstances traceable to war conditions, and take measures to eliminate them. Simultaneously with such examination the industry should be called upon to prepare a scheme indicating the contribution it can afford to make towards this object.

272. After all the data have been collected showing the maximum possible reduction, the reduced prices can be given effect to provided that the Government are satisfied that the benefit of the reduction will be passed on to the consumer and that thereafter the prices can be maintained at reasonably steady levels.

273. Serious, frequent and almost violent fluctuations in the selling prices in the past have had a deterrent effect

on the consumption of iron and steel. This was largely due to the fluctuation in the import prices of foreign products. With the elimination of this disturbing factor, the stabilisation of prices will be less difficult and measures should be taken to achieve this purpose, in so far as the primary products are concerned.

274. A "Stabilisation of Price Fund" should be constituted and should be sufficiently large to finance not only the stabilisation of prices, but also:—

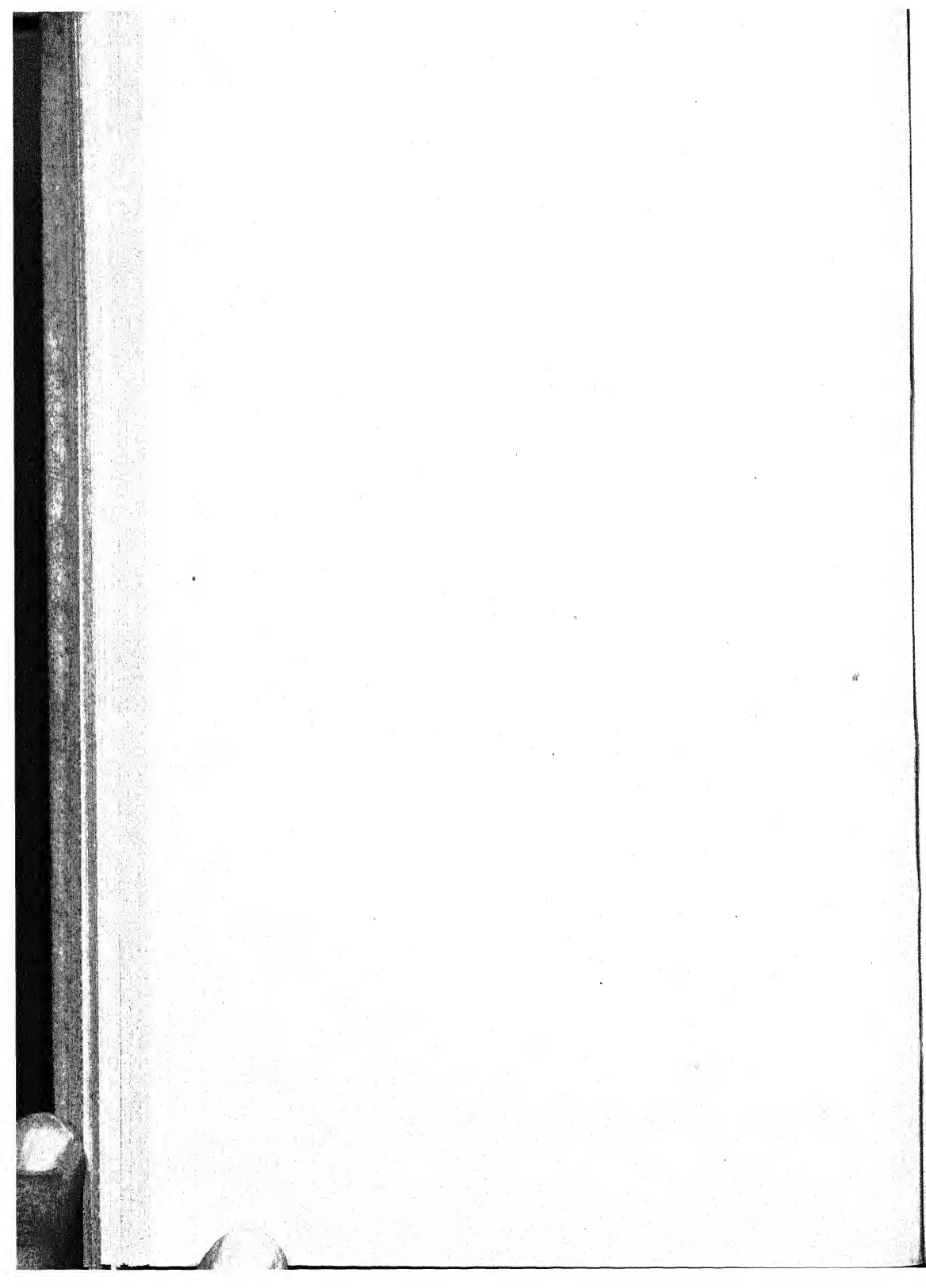
(i) the mitigation of the unequal burden of the cost of transport to the more distant markets;
(ii) stocks of iron and steel to prevent a shortage of supply which has been a fruitful source of profiteering on the part of dealers, stockists and other distributors with detrimental effects on prices and consequential reduced consumption; and
(iii) imports to the extent to which they are not financed by private importers when such are permitted.

275. The Selling Organisation should be charged with the duty of administering the Fund; and machinery should be provided for the scrutiny and auditing of the accounts.

276. In our second Report we shall deal with the following secondary and subsidiary industries dependent on the use of iron and steel. The substance of this section of the Panel Report appears in the part of the volume dealing with the industries connected with the Scientific Instruments, in the Summary of Developments.

(i) Re-Rolling Mills Industry;
(ii) Engineering Industries;
(iii) Alloy, Tool and Special Steels.

K. T. Shah.



REPORT OF THE SUB-COMMITTEE

ON

INDUSTRIES CONNECTED WITH SCIENTIFIC INSTRUMENTS

PERSONNEL

of the Sub-Committee on "Industries connected with the Manufacture of Scientific Instruments."

Chairman :

Dr. P. N. Ghosh, M.A., Ph.D.

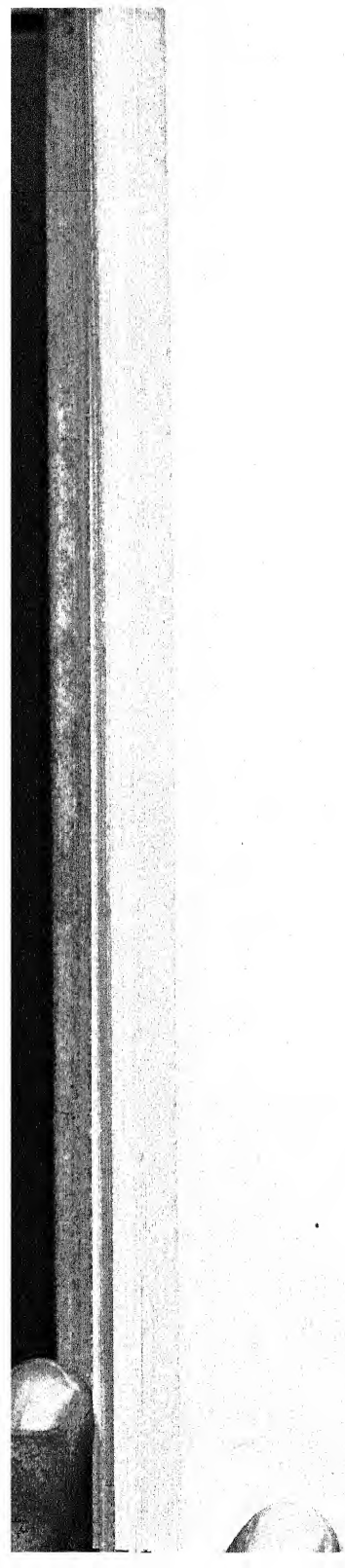
Secretary :

Principal G. R. Paranjpe, I.E.S.

Members :

Shri G. I. Patel
Shri A. K. Ganguli
Shri N. M. Athavale
Dr. M. Venkat Rao,
Shri K. B. Rao
Mr. M. A. Fazalbhoy
Shri N. G. Motwane
Shri G. N. Bannerjee
Shri B. N. Das Gupta

CONTENTS.



INTRODUCTION

The Sub-Committee on Industries connected with Scientific Instruments was appointed to consider the following terms of Reference: The general terms of reference and terms of reference under the group "industries". This Sub-Committee may elaborate its own scope of enquiry.

Here is another essential industry, without which our national ambition of self-sufficiency and all-round industrialisation cannot be attained. The term "scientific instruments and appliances" is applied to many instruments used in Universities, Hospitals, and Laboratories. They require to be produced with a very high standard of artisan skill, which can only be developed by generations of practice and experience. These instruments and apparatus are made of a large variety of materials for which the basic metals, excepting for castings, are non-ferrous, not available in the required quantities in this country, and therefore imported from abroad.

Before the last war, there was practically no production of such instruments in this country. A number of concerns were producing simple instruments and apparatus; but they were not on a large scale, and so proved necessarily much more costly, and their products were less precise. It has been estimated that the indigenous production of such instruments met only 5 per cent of the national demand in that regard.

Owing however to the exigencies of World War II, the number of assembly plants or maintenance workshops was increased. A few manufacturing establishments making scientific stores for Defence Services were also built up. These were mainly on the line of Fire Protection and Control, and associated stores of artillery, surveying and drawing instruments, a certain amount of signalling equipment, and the like. Most of these were produced before the war by foreign private enterprise; but the newly established concerns have developed the production of a number of simple instruments and apparatus. Laboratory glassware, which is indispensable for the production of scientific instruments, has also expanded considerably during the War period. As, during those years, price was no concern, the develop-

ments attending this industry cannot be relied upon as an index of the potentiality in the post-war period. On the other hand, we cannot dispense with this most essential industry, as without it the industrial growth of the country and its proper Defence would be impossible. Whether it is begun as purely a repair service for instruments already in stock, or whether we start, **ab initio,** the enterprise in all its varieties, its contribution to the building up of the rest of our industrial system is unquestionable.

The capital cost involved is, according to the Panel Report, by no means very large; and the aggregate output which would be needed would be considerable. Industrial Research and Technique, which daily make rapid progress, demand a much larger number of instruments and apparatus. They can be produced in India, if only the production is properly organised and rationalised.

The first thing to do in rationalising this industry is to standardise the type of the instruments required. Several Sub-Committees of the National Planning Committee have recommended for this purpose a Bureau of Standards, similar to the National Physical Laboratory at Teddington in England, or the Federal Standards Bureau in the United States. Without the aid and co-operation of such Scientific Bodies for testing and certifying the precision instruments of all types, there would be no hope of developing such an industry to its full dimensions, and of a right character. The greater portion of the use of these instruments is by highly educated scientists, whether trained in our universities, in the various departments of Governments, or in highly advanced technical industries. In so far, however, as they are themselves educated in other countries, they would have a partiality for the make and type of the apparatus they are accustomed to. They would, therefore, naturally recommend those makes, unless they are guided in their research and choice of instruments by a National Standardisation Organisation, testing and certifying corresponding instruments of Indian make.

Given the high cost of labour and technical skill involved in producing such instruments, it would be impossible to plan such an industry on the basis of self sufficiency unless the output is on a large scale. Mass production of this type can only be undertaken if the consumers' needs are themselves standardised, and production is confined to a few types only.

As all industries of an essential character, vital to the very existence of the country, this also would bear the best

fruits if it is from the very start nationalised, and operated as a collective State Enterprise. The absence of any vested interests worth the name, and the high working cost which would be unavoidable in the early years of the industry, not to mention the universal need of such instruments throughout the country in essential services, make a Government enterprise of this, a National Monopoly, impossible to object to by anybody. Government would be free to adopt any measure of protection necessary to develop the industry to its legitimate proportions, which might not be available if the industry was left in private hands. Even if some imports of extremely rare and highly technical instruments is unavoidable, Government would be in a much better position to organise and distribute such imports than any private enterprise.

As an entertainment business, the cinema and radio have made very great strides. The basic materials and instruments for them, however, are not yet made in this country which still remains, essentially speaking, dependent upon foreign supplies. The instruments and apparatus mentioned above required for all stages of public education will include these items also. So long as the country remains without the basic industries concerning the production of these materials, our national economy cannot be said to be on a basis of self sufficiency produced from our own resources of our essential needs.

K. T. SHAH.

SYNOPSIS

of the Report of the Sub-Committee on "Industries connected with the Manufacture of Scientific Instruments"

CHAPTER I.

The Role of Scientific Instruments in Modern Life and the Place of Manufacture of Scientific Instruments in the General Scheme of National Economy.

In every walk of life, in every society, in every industry, in every organisation, the normally unseen hand of the scientific instrument can be detected. If India is going to be really industrialised,—a step which ought to have been taken much earlier than now,—it is important not to be ignorant of the enormous utility and extremely close connection of the scientific instruments on the various industries. India's dependence on foreign countries in this vital question of the indispensable tool, viz. the scientific instrument, is a great block to the growth of Indian industries.

CHAPTER II.

Classification of Scientific Instruments.

All kinds of useful scientific instruments are classified in a number of divisions or groups, which are, as far as possible, non-overlapping. The instruments falling under each group are approximately based on the same scientific principle or have nearly identical construction. It would be desirable if manufacturers undertake work in one or other similar types of construction and specialise in them rather than attempt to manufacture diverse types of instruments. A list like the one given herein cannot be exhaustive; it cannot also be expected to be unique. It merely shows the principal instruments employed in industry, engineering, hospitals, educational and research institutions and in domestic economy.

Lists are given in the next chapter of instruments that are already made in India using either entirely or partly Indian raw material.

CHAPTER III.

The present state of the Scientific Instruments Manufacturing Industry in India.

The output figures of local manufactures and of foreign imports under various heads are not available in a classified

form. A list is given of the known manufacturers of scientific instruments along with the kinds of appliances that they prepare. From the available information, it is clearly seen that the industry of scientific instruments is still in a very elementary stage both as regards variety and quantity, although the quality of some of the products is excellent.

A very systematic effort will have to be made, with the co-operation of the Standardizing Institutions or the newly formed Board of Scientific & Industrial Research.

There is ample scope for the establishment of this industry in India for its usual peace-time activities or its unusual defence activities, and it should be the concern of both the Government and the Public to support this industry. In all stages of its growth the industry will provide intellectual and manual employment to the youth of this country. Indian public will be more and more science-minded through familiarity with numerous scientific instruments and appliances of local manufacture. The establishment of this industry will remove the main obstacles in the way of full scientific advance of this country. The obstacles are high price, inaccessibility of certain types and consequent want of confidence.

CHAPTER IV.

Raw Materials, Their Supply and Problems for Investigation

The necessary raw materials for this industry are very varied. Broadly speaking the raw materials can be described as Wood, Metals, Glass, Wires, Tubes, Abrasives, Ebonite and Plastics, Rubber, Paints, Varnishes and Enamels. Most of these, except wood, are of foreign origin and although they are available in the country, every attempt should be made to secure complete independence in this respect. The instrument maker, generally speaking, is a user of semi-finished or completely ready components. His main task is assembly with a specific purpose. This is an inevitable stage, not only in the beginning, but probably for all time to come. Even in foreign countries where the industry of scientific instruments is well-established, the manufacturing places are large assembly-plants. But there is a clear difference. In foreign countries the raw and semi-finished components are made in the country, whereas in India the industry depends exclusively on foreign imports.

It should be the concern of a central Indian organisation, like the National Planning Committee, to foster the intensive production of the essential raw materials. The manufacture of these materials will never be the legitimate business of the instrument maker. He should be able to secure them and build them into a useful instrument. A happy co-ordination between

different manufacturing industries and scientific research institutions would be regarded as important. The whole industry of optical instruments is as it were held up for want of the very important raw material 'optical glass'. Similarly, the manufacture of electrical measuring instruments are entirely dependent on the production of suitable 'magnetic steel'.

The recommendation is made that the manufacturers of scientific instruments should co-ordinate their activities, think in terms of specialization, mass production, follow co-operative methods of securing raw materials and make full use of the different scientific research laboratories and test houses in the country.

CHAPTER V.

Labour in the Industry, Skilled & Unskilled; Training Organizations.

The question of trained labour and the provision of highly skilled technicians in all phases of this industry is considered in this section. There are the usual difficulties of obtaining this kind of labour. The class exists, but it is not easy to make full use of this class. The skilled workman has no education and the educated workman is unable to appreciate the value of skill and precision. There are certain facilities for training the necessary type of workman; but most of them are only an indirect approach to the requirements. The educational institutions give the training academically and the employer trains his own labour. Most of our existing institutions of the type mentioned above are engineering schools and colleges, engineering workshops and some small manufacturers of scientific instruments. Neither of them is likely to meet adequately the supply of trained labour either for the scientific instrument manufacturing centres that exist, or for the new ones that would have to come into existence under the force of circumstances.

Special investigations would have to be made by a Committee of Experts to evolve a scheme of training for this purpose, in theory and practice, in the economics of the industry, either by using the existing educational and industrial institutions or by augmenting their resources according to a systematically planned programme.

A definite effort will be necessary. It will cost money and it will, probably, have to be carried out relentlessly with the support of the Government, backed by public opinion, because it would eventually bring about a complete change of social order. Educated unemployment would gradually disappear and the workman will acquire a social status which was so far not willingly given to him.

CHAPTER VI.

Machinery and Machine Tools.

In addition to the usual machinery and workshop equipment, the scientific instrument maker needs certain types of precision and specialized machinery. All the types of machinery have to be purchased from foreign manufacturers. A large number of tools like chisels, cutters, etc. can be conveniently forged in this country by skilled ironsmiths, but the quality tool steel is again an imported material. It should be the business of the industrial and research organizations in co-operation with metallurgical industries to evolve the manufactures of the necessary quality of tool steel.

Lathes, drilling machines and similar machinery can be manufactured locally in large engineering workshops, and when that will be done, the scientific instrument maker will be able to procure his essential equipment at home and at a comparatively convenient price.

There should be a co-operative plan of using the different moulding establishments, welding workshops, electroplating plants. This will lighten the task of the scientific instrument maker, because, although he has to depend on such establishments in his trade, he can never be expected to economically maintain them for his own exclusive use.

The precision type of machinery is most important and probably the most expensive item in this industry. Individual instrument makers can seldom afford this kind of equipment, and yet it is so essential from the point of view of reliability and precision. There is, to start with, enough machinery of this type available in India in some of the large Government owned and controlled workshops as well as in larger engineering establishments. Some educational institutions also have certain types of precision tools. It is, therefore, recommended that a scheme should be worked out whereby use could be made of the existing facilities for training, production and design of other machinery which can be economically built up in India.

Extensive use of precision machinery by the right type of workman, and the production of large quantities of standard precision instruments will set up a new standard on our expectations and the quality of industrial production will undoubtedly improve.

CHAPTER VII.

Standardizing Institutions & Industrial Research Organisations.

The information supplied in this Chapter divides itself into four major heads. Firstly, fundamental and derived standards

in different conventional systems are described particularly with reference to their historical background. Secondly, the functions and objects of standardizing organisations are described. Thirdly, descriptions of typical standardizing institutions in other countries are given. Fourthly, a recommendation is made for the formation of a Central Council of Standardization for the whole of India, with provincial standardizing laboratories, containing departments equipped to investigate the peculiar needs of the Province.

In almost all industrially progressive countries such standardizing institutions are maintained by their respective governments and they work in close co-operation with the different manufacturing industries of the country.

1. It is the business of these institutions to fix up primary and derived practical standards.
2. These institutions systematically get into contact with the problems of all the numerous industries and services that employ scientific instruments for the purpose of production, control and measurement. They can thus hope to render adequate technical assistance and advice.
3. These institutions can supply the necessary technical information from all sources of literature and experience.
4. They can either themselves undertake or cause others to undertake investigations of different kinds of raw materials, examine designs and plans and make necessary recommendations.
5. It is also a function of these establishments to test and grade the various kinds of manufactured components and complete instruments as regards their utility, cost, precision, efficiency, and so forth.

Establishment of these institutions would definitely contribute towards production of high-class instruments and this would naturally lead to considerable advance in the scientific and industrial achievement of the country.

CHAPTER VIII.

Location and Order of Preference in the Selection of Industries Connected with the Manufacture of Scientific Instruments

This is very largely determined with reference to India's present needs, to availability of the kind and amount of raw material from Indian and foreign sources, to the extent of skilled labour that is available, to the extent of available capital and to the condition of the market. Information received

from existing manufacturers has been very scanty and ambiguous. The exact manner in which useful information regarding each industry should be collected is indicated in the two specimen notes pertaining to the manufacture of Scales and Balances and to the manufacture of D.C. electrical measuring instruments.

A somewhat disturbing feature is noticed among all manufacturers. Most of them manufacture the same articles, with the result that technical skill is not utilized to the fullest advantage. It is recommended that this should be avoided and new fields should be worked out.

CHAPTER IX.

Responsibility of Government in matters of control, financial and technical assistance, creating adequate training facilities in India and in foreign countries, enacting necessary legislation

It is recommended that this industry should be directly conducted by the Government, because of its all pervading character and national importance. But as a matter of expediency, some manufactures may be left in private hands under Government supervision and control. In this manner Government would be able to obtain the necessary statistical information in connection with the innumerable scientific instruments that are constantly being employed in educational institutions, Universities, Research Departments, Medical Establishments and Hospitals, Communication and Transport services, large and small manufacturing industries, etc. in the whole country.

Government can induce an intensive study of Applied Physics in all its aspects and initiate and encourage directly schemes of Industrial Research. A definite and carefully planned out scheme for training of technicians, of all levels, can be effectively worked out with Government assistance. Establishment of Standards Institutions and Test Houses can also be possible only through Government assistance and necessary legislation. It would also be the responsibility of Government to devise suitable legislation in matters relating to patent rights and protection.

CHAPTER I.

THE ROLE OF SCIENTIFIC INSTRUMENT IN MODERN LIFE AND THE PLACE OF MANUFACTURE OF SCIENTIFIC INSTRUMENTS IN THE GENERAL SCHEME OF NATIONAL ECONOMY

It would not be far from the truth to state that it is difficult for ordinary people to realise the part played by "Scientific Instruments" as an essential element of our present civilisation. It is only when one applies oneself to critically examine the different factors required to satisfy his every-day need one finds that practically at every step one meets with this ubiquitous tool. In every walk of life, practically in every level of the society, in every industry, in every organisation, the normally unseen hand of this indispensable element could be easily detected. One is often led to think that in the present day complicated city life, in which arrangements have to be made to accommodate large number of people within a limited space, the question of their food supply, their means of locomotion, the sanitary arrangements required for their healthy existence, is a necessary effect of our civilisation. One has to adopt artificial measures to meet the exigencies of the situation and to seek scientific equipments.

But let us turn our attention to villages, to people dependent on agriculture. Is it not a fact that steel required for all his cutting implements—the ploughshares, the knives, the spades, and the sickles—is supplied from big metallurgical industries where, to secure the necessary qualities of steel and iron, one has to rely on the performances of scientific instruments? The materials required for his utensils—brass, copper and bell metal—are also procured from establishments where scientific instruments are indispensable. Excepting perhaps the primitive folks living in jungles, nomadic in character, it would be difficult to find people living in any form of society dispensing with the use of these instruments.

A little consideration would indicate that this vast subcontinent of ours, a land of two millions of square miles extending from latitude 6° to 37° N, has to be surveyed for purpose of administration. Would it be difficult to realise that to carry on survey operation a number of precision

types of scientific instruments such as the standard of length, the theodolites, the levels, measuring tapes, etc. are necessary? Then the host of other instruments have to be requisitioned for the purpose of drawing out comprehensive plans, to determine the areas to scale, and to decide the boundaries between the different sections of the country. The land settlement and land administration would be an impossibility without the aid of scientific instruments in our present state of society.

The most common scientific instrument that is in constant use by millions of people is the watch. It is indeed difficult to realise how the time element has been intricately linked with our life. We have really forgotten the stage at which people used to determine the time of the day by looking at the sun or at night by looking at the stars. For people living in villages far removed from the city the practice still prevails but this is not going to last a long time.

In ordinary business transactions and in interprovincial trades, standardised measures and standardised weights have to be used. India as an exporting country, has to requisition weights and measures consistent with International practice.

In the industries that have already been started in India, e.g., the Textile mills for supplying clothing to the millions, has it been realised that in every stage of this industry from the weighing of the cotton as it reaches the mill to the finished cloth as it leaves the mill, how many varieties of measuring instruments and scientific instruments are requisitioned in conducting the various operations?

In the steel industry, one has to think of power production in large units and the power generating station with its steam raising plant, its high pressure turbine, its generator, and its switch-board, which really indicate a diversity of scientific measuring instruments without which one could never think of generating power. In the furnaces for the production of pig iron and steel and in the rolling mills, the performances of the units are regulated and controlled by suitable scientific instruments. The structural steels are according to a definite standard laid down by Engineers and as such their production is regulated with the help of suitable measuring devices.

In the mining industries at every stage one meets with a variety of instruments not only for the safety of the

underground workers but also to carry on the normal operations.

Our heavy chemical industries cannot do away with instruments of different types for they have to conduct their operations under suitable conditions. These conditions are regulated with the help of measuring instruments.

In the science and practice of healing, has it been noticed that a number of instruments are essential to detect human maladies and to provide for their cure?

If India is going to be industrialised, a step which ought to have been taken much earlier than now, one should not be ignorant of the utility and the dependence of scientific instruments on the various industries.

In every country industrially advanced, one notices side by side with industrial developments, the growth of concerns dealing with scientific instruments as a handmaid to industries. So long we had been entirely dependent on outside sources but for a poor country the prices to be paid for this indispensable tool is a great block to the growth of industries.

The manufacture of machineries and the production of machine tools are as much needed for the industries as the instruments which guide and regulate every step of a mechanical process and check any deviation from the standard values.

Without hesitation it would not be improper to lay down that for the social advancement and the maintenance of social order for industrial development, the industry of scientific instrument occupies a fundamental position.

CHAPTER II.

CLASSIFICATION OF SCIENTIFIC INSTRUMENTS

The manufacture of scientific instruments is certainly an item of national importance, inasmuch as it occupies an eminent place in our scientific and engineering developments and corresponds to the manufacture of heavy chemicals in all chemical and allied industries. There is, of course, this important and obvious difference that the number of different heavy chemicals is small while the number of different kinds of scientific instruments is almost innumberable. It is difficult to accurately define a scientific instrument, but **anything which facilitates work can be described as an instrument**. A watch, a two-ounce measurglass, a typewriter, a sewing machine, a clinical thermometer, a fountain pen, weighing scales, spectacle lenses, a call-bell are only a few of the literally innumerable instruments that play important roles in our everyday life. The name 'Scientific instrument' does not necessarily indicate any particular set of instruments which are scientific as against those that are not scientific. One can say, without exaggeration that almost every instrument is scientific, because it is based on some scientific principle. The name scientific instrument, perhaps, indicates a classification suggesting that it represents a type of instruments employed in scientific pursuits in educational, industrial and research laboratories. Instruments employed in public utility services, like the telegraph, the telephone, motor cars, aeroplanes, air conditioners etc., etc., are invariably scientific although they are not necessarily used only in scientific institutions. It is not possible to have any unambiguous classification of scientific instruments. According to one mode, all instruments can be divided into two categories. Those that are single instruments fall into the first category and those that are complex and assembled out of the requisite number of single instruments, to become a serviceable unit, fall into the second category. A spark plug, a valve, an ignition coil, a carburetter etc., are all single instruments of the first type. Different kinds of toothed wheels, springs, escapements etc., are single instruments of the first type, while a watch or a clock is an instrument of the second type. A permanent magnet, a coil,

a watch spring or a suspension or circular scale are instruments of the first type while an ammeter or a voltmeter are instruments of the second type. Any number of instances can be given in this manner to illustrate this particular mode of classifying scientific instruments.

There is another mode of classification and it is also convenient for some purposes. All instruments that are either labour saving or general utility appliances can be grouped under one head, while all others that are primarily employed in measuring different quantities like length, area, weight, temperature, pressure, electric energy, etc., can be grouped under the second head. Telegraph, telephone, engines, lifts, pumps, fans, etc., are some of the best illustrations of the first, while tapes, scales and balances, thermometers, taximeters, energy meters, water-meters, etc., are illustrations of the second type. It is customary to describe the instruments belonging to these two different types as public utility instruments and measuring instruments. Which particular method of classification is employed is not of consequence, since it will vary from time to time and will depend largely on the circumstances and the points of view. A carbonic acid gas recorder, a ph-meter, a planatanium, a sound-film projector, a multiplying machine are all scientific instruments, and it would be difficult to place them beyond doubt under one or the other head. They are all complex and built out of numerous elementary instruments, which are common to most of them. The following list shows some typical instruments which are quite essential to the maintenance of industrial development with a view to achieve almost complete industrial independence:

1. Scales (for measuring length), slide-rules, Micrometer Gauges, etc.
2. Pressure Gauges, Vacuum Gauges, Manometers etc.
3. Clocks and watches (mechanical, electrical).
4. Levels.
5. Thermometers, hydrometers, etc.
6. Microscopes, Telescopes, Polarimeters and other optical instruments. Binoculars and other prismatic instruments (Mirrors, lenses, prisms etc.)
7. Air pumps, water pumps (all types), compressers.
8. Electric motors (small sizes) used in driving numerous scientific devices.

9. Electric meters of all kinds, Volt, Amp, Watt, Energy, Megger etc.
10. Photographic materials:
    (1) Cameras of all kinds, (2) Photographic accessories like plates, films, paper.
11. Heating units, Temperature controls used in thermostats, incubators ovens, furnaces ect.
12. Electric type thermometers, recorders, controllers etc.
13. Surgical instruments.
14. Radio Components, condensers, resisters, coils etc. Switch gear, dials etc.
15. Radio Valves.
16. Instruments connected with Telegraphy and Telephony.
17. Magnets, permanent and temporary, small and large.
18. Steel springs; Springs of other special alloys.
19. Weighing machines of all types (automatic and platform).
20. Mathematical Instruments.
21. Burners (household, laboratory, works).
22. Asbestos boards and other asbestos articles.
23. Stoves (oil, gas, electric).
24. Electric batteries (primary, secondary, wet and dry); Plates, Electrodes, Containers, Separators.
25. Gas mantles (for lamps consuming gas).
26. Laboratory fittings.
27. Presses, filter presses, cork presses, rollers, dies.
28. Centrifuges for laboratory and industry.
29. Calorimeters for laboratory and industry.
30. Barometers (all types).
31. Lamps (Electrical) quartz, mercury, sodium vapour, spirit lamps, and other kinds.
32. Spectroscopes with all accessories of high resolving powers and for testing ground surfaces of glass.
33. Projection apparatuse, Episcopes, Epidiascopes, Cinema projectors for pictures and sound.
34. Autoclaves, Steam Sterilizers.
35. Sieves of all kinds.
36. Meteorological instruments like rain gauges, sunshine recorders, weather columns, charts, anemometers, automatic devices for recording, Seismographs, magnetic instruments.
37. Surveying instruments.
38. Scientific models.

39. Haemometers.
40. Gasometers.
41. Galvanometers of all types.
42. Milk analysis apparatus.
43. Shaking and stirring appliances of all kinds.
44. Balances and scales (spring, beam). Physical, Chemical, Micro and other kinds.
45. Colorimeters, Densimeters.
46. Photometrical appliances.
47. Photo-cells.
48. Scientific toys of all types.
49. X-ray appliances and accessories.
50. Diathermy, electric (cautery), polarization etc., for medical use.

The list does not by any means pretend to be exhaustive, as it contains only a few typical illustrative items, which are chosen in such a manner as to avoid unnecessary overlapping. A number of these above-mentioned articles are already manufactured in India, but merely because the products are new, they have not yet been able to command the necessary attention. The users cannot feel certain as regards the quality of these articles. This is perhaps as it should be very naturally in the early stages of any new industry. But the industry of scientific instruments must occupy a peculiar position. It may not catch the imagination of the lay public, but it must be the special care of the industrialists, educationists and researchers, who should uniformly champion the cause of local manufactures, because such a frame of mind alone can give proper encouragement to enterprising designers, inventors and mechanics. It should also be the anxiety of all industrial and scientific institutions to foster the spirit of depending as far as possible only on appliances of local manufacture. This would eventually narrow down or efficiently bridge the wide gulf which separates pure science from applied science in this country. **Science itself is an instrument** which contributes so largely to the advancement of our social happiness, but this fact is not equally obvious to the layman and therefore he is unable to appreciate the numerous advantages of science. High price and general ignorance about the numerous scientific aids that we use in our daily life are some of the principal causes that help to maintain in the minds of the layman an atmosphere of mystery regarding scientific appliances and devices. To most of our countrymen scientific instruments are nothing more than

luxurious toys. Once they get out of order, due to some mechanical defect or due to owner's negligence, they remain idle ready to be scrapped. The very large number of motor engines, electric fans, lenses, clocks, photofilms, radios, razor blades, glassware, etc., that are scrapped every year can give a rough idea of the increasing dependence of our national scientific progress on foreign imports.

CHAPTER III.

PRESENT POSITION OF THE INDUSTRY OF MANUFACTURING SCIENTIFIC INSTRUMENTS IN INDIA

The stability and the growth of a particular industry in a country can be assessed by the degree of independence it has achieved in respect of the necessary raw materials, tools of manufacture and demand and sale of finished products. There are obviously numerous other facts like trained labour, finance, protection, manufacturing and trading facilities and the like, but these can all be generally grouped under the three main heads given in the beginning; because finance can be looked upon as raw material, trained labour as tool of manufacture and so on.

What is said above regarding industry appears to hold true in the field of education, medical profession, civic developments, and in fact in almost all aspects of our modern life. Soon after the present war began considerable difficulties became obvious in the path of such of our manufacturing industries which depended exclusively on foreign raw and intermediate materials. This should not have caused any surprise, because in 1914, when the last World War came to be launched in Europe, the situation in India was not different. It must be admitted that there have been, in the last twentyfive years, many successful and unsuccessful attempts at establishing and developing important industries. But the net result is not very encouraging. The experience of a war like the present one shows vividly that nothing short of a well-thought-out plan, with full support of the Government and the public, and a sustained all-India effort will place the industrial prosperity of the country on a solid foundation.

As a result of the commencement of the present War, the medical profession realised once more the big handicap in not being able to command all the appliances, drugs and medicines, which it has been accustomed to use very successfully so far. To quote a particular example from one of the largest industries of this country—the textile manufacture is already seriously feeling the shortage of bleaching powder and dyes. Waterworks, belonging to large and small municipalities, are unable to employ chlorine with consequences which may be very harmful.

The educational and research institutions all over the country began to wonder as to how they would be in a position to continue their activities, which are essentially of a nation building character, in the absence of numerous appliances and equipment which they used to import very largely from abroad. The printing paper for the press has become scarce and expensive. Large photographic and cinema concerns are obviously paralysed, because they thrive almost exclusively on imported articles.

The present position as regards scientific instruments in this country is such that they are finding more and more employment in all spheres of life. With the spread of education, leading to higher standards of living and rapid industrial developments, the employment of scientific instruments is increasing rapidly. This is probably a good sign, suggesting progress, but unluckily the development is one-sided and somewhat unreliable, unless India can safely depend on manufacturing all the requisite instruments in this country and out of local raw materials. There have been and there are even now some enterprising concerns that endeavour to manufacture scientific instruments, but the sum total of all such attempts is yet only a drop in the ocean. It would not be an exaggeration to say that the demand on scientific instruments and appliances is almost wholly met from articles of foreign manufacture.

The oldest, the largest and the most extensive kind of manufacture of scientific instruments is undertaken by agencies directly under Government control. The most notable are:

(i) The Mathematical Instruments Office, Calcutta;
(ii) Telegraph Workshops, Calcutta;
(iii) Meteorological Departmental Workshops, Agra and Poona.

They manufacture and repair the most complicated kinds of instruments with the most efficient machinery that is available at the moment. Their activities have been mainly to supply the needs of Government Institutions and offices.

There are, however, in the country a number of firms that do make all kinds of Scientific Instruments, and the following is a list of firms that are known to manufacture Scientific Instruments in India:—

1. Oriental Scientific Works, Ambala;
2. Hargolal & Sons, Ambala;

3. Scientific Apparatus and Chemical Workshop, Ltd., Agra;
4. The Scientific Instrument Co., Ltd., Allahabad;
5. Benares Balance Works, Benares City;
6. General Mfg., Co., Sonarpura, Benares City;
7. Govt. Electrical Factory, Mysore Road, Bangalore;
8. Mysore Scientific Instruments Syndicate, Bangalore City;
9. Andhra Scientific Co. Ltd., Masulipatam;
10. The Krishna Model Mfg., Co., Abbot Road, Lahore;
11. Krishna Plaster Works, Ltd., Lahore;
12. The Capital Science and Technical Works, Daryagunj, Delhi;
13. Dayal Bagh Industries, Dayal Bagh, Agra;
14. Bengal Chemical & Pharmaceutical Works, Ltd., Calcutta;
15. Nadia Chemical Works, Calcutta;
16. Scales Mfg., Co. Gaiwadi, Bombay 4;
17. Ramachandra & Sons, Girgaum, Bombay, 4;
18. Bombay Surgical Co., New Charni Road, Bombay, 4;
19. N. Powell & Co., Ltd., Lamington Road, Bombay;
20. Allibhoy Valljee & Co., Multan;
21. Gulam Nabi & Co., Lahore;
22. Upper India Scientific Works, Lahore;
23. Laboratory Apparatus Works, Poona 4;
24. Raj-der-kar, Commissariat Bldg., Hornby Road, Bombay 1;
25. Industrial & Engineering Co., Chottani Estate, Proctor Road, Bombay, 4.

On behalf of this sub-committee, these firms were requested to supply information on specific points. The first question was.

"The kind and type of articles usually manufactured by the firm."

The replies received from the manufacturers on this point are given below in original, but in a classified, form:—

Reply from (2) Hargolal & Sons, Ambala:

Manufacture all sorts of:

(a) Physical Apparatus, as are usually given in the standard catalogues of British firms, such as Becker & Co., Baird & Tatlock (London) Ltd., covering the different sections, such as light, sound, heat, Hydrostatics & Mechanics, Magnetism, etc. Chemical Apparatus, Biological Apparatus, Geographi-

cal Apparatus, and other instruments and appliances, useful in teaching in schools and colleges;

(b) Laboratory fittings, such as sinks, tables, stands for test tubes, etc.

(c) High grade balances, weights, and other items as given below:

Apparatus for physics and chemistry, botany and nature study, biology, physiology, and anatomy. Geography survey and drawing. Laboratory benches, water and gas fittings, numerous other appliances for educational institutions and research laboratories. All kinds of tools, models, slides, charts and pictures.

Reply from (3) Scientific Apparatus & Chemical Workshop, Ltd., Agra.

Generally manufacture all sorts of Scientific Instruments, but specialise in the following:

Physical Apparatus:

(a) P.O. Boxes and Resistance Bridges (both Plug and Dial type) Potentiometers, Kohlrauchs Bridges, Volt Box, etc., upto the accuracy of 0.1% and .05%, adjustable resistances, and high power electromagnets.

(b) Spectrometers reading to one minute, Ripple Projector, Optical and Photometer Benches.

(c) Wave Motion Apparatus, Melde's Apparatus, Siren, etc.

(d) Reading Microscopes and Telescopes, Boyles' Law Apparatus, Young's Modulus Apparatus, Kater's Reversible Pendulum, Spherometers, etc., etc.

Chemical Apparatus:

Stills, Ovens, Sterilisers, Baths, Burners, Water Taps, Gas Taps and other Laboratory requirements.

Biological and Physiological Apparatus:

Dissecting Microscopes, Recording Drums, Kymographs and other Physiological Research Apparatus.

Reply from (4) The Scientific Instruments Co. Ltd., Allahabad:

Our field of manufactures covers the entire range of Scientific Apparatus which are too numerous to be named herein. It may be, however, taken that we handle all kinds of glass blown and graduated glass instruments and appa-

ratus excluding thermometers, hydrometers, etc., at present.

We also undertake manufacture of all kinds of metallic physical and chemical apparatus of the coarser kinds, not involving the use of magnets, electrometers, fine graduations or optical parts.

Reply from (5), The Balance Works, Benares:

Analytical, Chemical and Physical Balances & Weights and many other sheet-metal apparatus.

Reply from (7), Govt. Electric Factory, Bangalore City:

We are manufacturing Scientific Instruments useful for the Civil Engineering Line and General Survey Work. Our object in starting this department on a small scale is to meet the demands of the Public Works Department of our Government mainly, by supplying both new instruments and repairing existing ones.

The extension of this department is in the direction of taking up the manufacture of more complicated instruments such as Theodolites, Binoculars, etc., and to meet the demands of outside market.

Details of the instruments are given below:—

14" "GEF" DUMPY LEVEL: Telescope, Spirit Level, Compass, Tribrach Box, Tripod.
"GEF" PRISMATIC COMPASS:
"GEF" LEVELLING STAVES:
ALL BRASS ROLLING RULES:
EBONY PARALLEL RULES:
DRAWING BOARDS:
T-SQUARES:
VULCANITE SET SQUARES:
PLANE TABLE:
PRINTING FRAME WITH STAND:
ZINC TRAY.

Reply from (17) M. Ramchandra & Sons, Bombay:

We manufacture laboratory and scientific instruments as follows:

(1) High Pressure Steam Sterilizers or Auto-claves;
(2) Incubators;
(3) Centrifuges (electric) and Shaker Machines;
(4) Hot Air Ovens;
(5) Instruments, Sterilizers of all kinds;
(6) Paraffin Baths & Ovens;
(7) Wassermann Baths;

(8) Water Baths of all kinds;
(9) Steam Sterilizers;
(10) Automatic Water Stills of all kinds;
(11) Micro-slide Steel Cabinets to hold about 14,000 slides;
(12) Microscope Slide Boxes (Wooden);
(13) Sherrington-Starling Recording Drums;
(14) Ophthalmic Stands and Brackets;
(15) All sorts of Gas Burners;
(16) All sorts of Water Taps;
(17) All sorts of Stands, such as Retort, Tripod, etc.
(18) All sorts of animal cages;
(19) Scales and Chemical Balances, and such other articles.

Reply from (20) Allibhoy Valljee & Sons, Multan:

We are manufacturers of the following articles:

Aseptic Hospital Furniture including Modern Operation Tables, High Pressure Sterilizers, Surgical Bedsteads, Surgical Instruments and Appliances, Steel Office Equipment, Airtight Uniform Trunks, Cash & Jewellery Boxes, Ice Chests and general sheet metal wares, etc.

Reply from (23) Laboratory Apparatus Works:

The Laboratory Apparatus Works are mainly manufacturing the following:—

1. Galvanometers including Index, Tangent, Pointer Combined Mirror and Pointer, Mirror Galvanometer of sensitivity upto 10 Amp. These range in price from Rs. 20 to Rs. 50.
2. Spectrometers ranging in price from Rs. 125 to 450.
3. Optical bench assemblies, prices from Rs. 150 to 450.
4. Travelling Microscopes and Micrometer slides and spherometers. Prices from Rs. 15 to 200.
5. Sliding Rheostats from Rs. 30 to Rs. 120.
6. Lense Magnifying Stands, Dissecting Microscopes, from Rs. 20 to Rs. 60.
7. Resistances and instruments for measuring resistances and pressure. From Rs. 10 to Rs. 600.

Experiments are nearly complete regarding the manufacture of D.C. Ammeters and Voltmeters.

During the next year probably, the manufacture of Dumpy Levels and Simple Class Room Microscopes will be tried.

Reply from (16) The Scales Mfg. & Adjusting Works, Bombay:

As regards the kind and type of articles manufactured by us please read the list appended below: We can also manufacture any kind of scientific instruments according to the specification furnished by our customers. We would like to add particularly that we have manufactured a model of platform weighing machine, which we believe has not yet been manufactured anywhere else in India.

The kinds and types of articles manufactured by the Scales Manufacturing & Adjusting Works:

Names of articles

1. School Balances of different capacities.
2. College Balances of different capacities.
3. Chemical Balances of different capacities.
4. Analytical Balances of different capacities.
5. Ray Balance, which is an analytical balance, is our speciality, and is manufactured to meet the most exacting need of the analyst and is approved by all research institutions, local as well as outside.
6. Weights from 100 grammes to 1 milligram with case and forceps, Fractional weights of aluminium. Standard weights in a wooden box for accurate analytical work, nickel plated and gold plated.
7. Glass blower pattern Blow pipe. Fletcher's compound Blow pipe.
8. Foot bellows No. 5", 10".
9. Glass cutting machine, to be mounted on bench complete with clamp and pressing handle.
10. Burners:—Bunsen burners, Micro Bunsen Burners, Teclu pattern burners with air regulating cone and disc for varying temperatures. Ring burners.
11. Gas taps:—One way; two way; three way; four way with chambers; gas nozzle with plate.
12. Water taps:—Single way water taps, three way water taps, Swan neck three way water tap; screw down water tap, standard right angle water tap.
13. Drying Ovens.
14. Hot water ovens.
15. Hot air ovens of different sizes.
16. Washing bath, dye bath, and evaporating baths of copper.
17. Furnace for sealed tube operations, insulated cover, double air space with burner.

18. Stirring apparatus, complete on stand and rope pulleys.
19. Single, double, treble pulleys.
20. Atwood machine.
21. Copper calorimeter heater.
22. Tuning forks.
23. Sonometer.
24. Joul's Calorimeter electrically heated.
25. Wheatstone Bridge.
26. Arc Lamp.
27. Short Circulating plug._
28. Tap Key.
29. Commutator double switch.
30. Forceps, plain and ivory tipped.
31. Young's Modulas Apparatus.
32. Coulomb's Torsion Balance Medium.
33. Tangent Galvanometer.
34. Galvanometer, lamp and scale.
35. Rheostats wound on porcelain cylinders, with sliding contact.
36. Aspirator.
37. Cork boring apparatus:—Cork borers of brass; Cork presser, of cast iron, well made; cork presser, wheel pattern.
38. Hot water funnel, double jacketed with stand 6" dia., and with rivetted legs.
39. Steam funnel with spiral round with outlet and inlet for steam, made of copper.
40. Deflagrating spoons.
41. Spatulas of german silver and rustless steel.
42. Gas holder made of best copper sheet, large size.
43. Wire gauze, asbestos and uralite.
44. Spirit level.
45. Levelling table.
46. Wooden blocks for holding 6 standard reagent bottles.
47. Stop cock for aspirator.
48. Test tube holders of best teak wood handle and without handle.
49. Universal holder or clip.
50. Straight tongs or with bow, nickel plated or gun-metal.
51. Triangles with silica tubes.
52. Triangles of a wire (iron).
53. Filter stands of various types.
54. Pipette stands of various types.

55. Retort stands of various sizes.
56. Filter rings with boss heads.
57. Clamps to serve various purposes.
58. Test tubes.
59. Thermometer rack.
60. Burette rack.
61. Burette stand and filter stand.
62. Hoffman stand.
63. Triangular and round tripods.
64. Geometric tripod stand of iron.
65. Circular table.
66. Circular wound copper tube for superheated steam.
67. Quadrupeds.
68. Automatic still for distilled water of any size (our speciality).

In addition to the above we also manufacture the following:—

1. Bullion balances and beam scales of different capacities, particularly used by His Majesty's Mint and Government treasuries.
2. Letter weighing scales and also weightless balance used for weighing letters.
3. Counter scales.
4. Yarn count testing scales.
5. Tube testing scale.
6. Weights:—

   Total weights from 1/32 tola to 2,000 tolas and also 3,200 tolas.
   Grain weights from .01 to 100 grain.
   Gram weights from 1 milligram to 10 kilogrammes.
   Rati and Wal weights used by jewellers and goldsmiths.
   Drachm and penny weights used by mills.

The second question asked of the manufacturers on behalf of the Sub-Committee was:—

The amount of turnover both in kind and in money value at the normal times: (If this information cannot be supplied, please say so).

The replies received are given below in original:

Reply from (2) Hargolal & Sons, Ambala

The amount of turnover cannot be given, as separate figures for sale of manufactured goods and for imported goods are not available.

Reply from (3) The Scientific Apparatus & Chemical Works, Ltd., Agra:

The total amount of the turnover of our Workshop in normal times is about Rs. 30,000/- a year for Sale Value.

Reply from (4) The Scientific Instrument Company, Ltd., Allahabad:

It is very difficult to give any idea of the quantities of things manufactured as they vary from a single one to thousands in a year, as the manufacture depends entirely on the fluctuating demand of our customers, our trade being entirely with consumers, and no stock is maintained as is usual in the business of wholesale dealers.

The amount of business in monetary value may be taken at about Rs. 2,50,000/- approximately annually in the Manufacturing Branch.

Reply from (5) The Balance Works, Benares

No.

Reply from (7) Government Electric Factory, Bangalore City

The amount of turnover is furnished below:

	Quantity	Value
Dumpy Levels	12	Rs. 3,600
Prismatic Compass	25	Rs. 2,500
Surveyors' Levelling Staves.	50	Rs. 1,250

Since the work has been started only a few months back, the figures do not represent normal turnover.

Reply from (17) M. Ramchandra and Sons, Bombay

We are sorry, we cannot supply this information.

Reply from (20) Allibhoy Valljee & Sons, Multan

Our annual turnover is worth over Rs. three lacs.

Reply from (23) Laboratory Apparatus Works, Poona.

No information.

Reply from (16) The Scales Manufacturing & Adjusting Works, Bombay

The annual output of our articles amounts approximately to Rs. 12,000/- and the value of our repairing and adjusting work amounts to the annual average of Rs. 10,000/-.

Excluding the Government Institutions like the Mathematical Instruments Office and the Telegraph Instruments Workshop in Calcutta, there are already in existence about a score of manufacturers of scientific instruments in India, but most of them devote themselves to the construction of just these few articles that are usually employed in educational institutions. Their products are good and they serve a very useful purpose. The articles manufactured cover a wide field including mechanical, electrical, optical, and thermal appliances, but the majority is still dependent on imported raw materials or ready-made components. In spite of this, the industry has made considerable progress. The passage through the assembly stage is unavoidable and yet very important; because it helps to train up workmen and develop confidence in their skill; it also gives the manufacturers time and opportunity to look about for local raw materials while the finished product, built out of foreign components, is becoming popular and attractive.

It is also necessary to introduce, among the different manufacturers, the idea of specialisation at a certain stage. Most of the manufacturers of educational instruments, large as well as small, are engaged, at the present time, in preparing post office boxes and spherometers. In fact each manufacturer makes all kinds of different instruments, with the result that the designers and the workmen have little chance of acquiring the necessary experience and skill to be able to produce articles of a definite quality. The purchaser, in spite of his anxiety to buy Indian made articles, remains perplexed. It would, therefore, appear necessary to establish independent or state-controlled institutions which will be in a position to critically examine the different products and grade them properly. This will considerably assist the buyer inasmuch as he will then know from the grading report what value he is actually receiving either in respect of quality or workmanship or cost. These institutions modelled on the lines of the N.P.L. would be able to render valuable assistance to the industry through its research departments, by undertaking special investigations to explore new raw materials, to examine new designs, to suggest various improvements to increase the efficiency of the manufacturer. These institutions will also arrange to equip themselves with special expensive tools and precision standards which individual makers of scientific instruments can hardly be expected to afford.

CHAPTER IV.

RAW MATERIALS, THEIR SUPPLY AND PROBLEMS FOR INVESTIGATION

Various manufacturers in this country were requested to send replies to the following specific question:

> "The main raw and semi-finished materials that the industry is generally dependent upon and the countries that supply them."

The replies that were received are given below in original, and it can be seen from most of the replies that the industry in India is yet in its infancy and is only a slightly better edition of the "assembly" type. Most of the raw materials, either in the form of semi-finished or completely ready components, come from foreign countries. This is, of course, inevitable and a good many of the foreign manufacturers of Scientific Instruments do resemble assembly-plants, but the raw and semi-finished components are also built in their own countries.

Reply from (2) Hargolal & Sons, Ambala:

The main raw and semi-finished materials that we generally require and depend upon other countries are:

(a) Iron, brass and copper and zinc, etc., in various shapes, such as sheets, nails, pipes, wire, terminals, screws, nuts and so on. These are generally obtained from Germany.
(b) Different kinds of wood, suitable for the purpose. These can generally be obtained from India.
(c) Paints varnishes, polishes, etc., all imported from Europe.
(d) Machines and tools, all German or English.
(e) Glass.

We do not feel any difficulty in procuring raw material, specially those that are available outside India.

Reply from (3) The Scientific Apparatus & Chemical Works, Agra:

As for the raw material, we generally require the following articles:

(a) Teak wood. We require Burma Teak, and it is available, being an Indian product.

(b) Sheets, tubes and rods of iron, brass, copper, tin and of other metals. These are foreign products but are available in the local market though the prices have gone up abnormally high owing to War conditions.

(c) Resistance Wires, insulated, mostly double silk covered, of Manganin, Eureka or Constantan and Oxidised Wires of Nichrome and Constantan. These are not available in India as these are neither manufactured nor stocked here generally.

(d) Sheets, rods, tubes, etc., of Ebonite and Bakelite. These are also not available easily here in India and they are not manufactured here.

(e) Optical goods, i.e., telescopes, and objectives, magnifiers, eye pieces, etc., etc. These were formerly imported by us from the foreign countries mostly from Germany. At present we are almost cut off from all such sources and due to the want of the goods we are unable to produce high class instruments. But now we have formulated a Scheme for producing these in our works. If we get the slightest support from the Government we can develop this side on a scale to supply these things to most of the needs for simple elementary lenses in the beginning and lenses of advanced character after some time. We require for this Raw Optical Glass which can be had from England.

(f) Paints, Lacquers and Enamels. These we get purely from sources outside India, and we are finding now a lot of difficulty in getting our supplies. If you can help us in this direction and introduce us to the Indian stockists and manufactures, if possible, we shall be highly obliged.

(g) Owing to the Continental War, the Raw Materials as mentioned above are not available in India and hence we can only produce the high class instruments till the present stock is available with us unless and otherwise some new sources are opened.

Reply from (4) The Scientific Instruments Co., Allahabad:

The raw materials consumed are of various kinds, the main items which we ourselves import from the manufacturers abroad are glass rods and tubing. Our annual consumption of this one item in normal times is about 80,000 lbs. worth about Rs. 60,000/-.

The other items are comparatively very small and either purchased locally or are imported from the makers, but such articles are very few.

The glass articles are mainly imported from Turingia; other countries, viz. England and U.S.A. do make them, but their costs being higher the final products cannot stand the competitive market.

The main obstacle in the advance of this trade of scientific instrument manufacture is the difficulty in obtaining raw materials cheaply. Any attempt towards their production in the country has proved abortive, because of the lack of support from the glass industries already running, secondly the absence of any manufacturing industries, e.g. sheet and metal rolling mills, alloy steel products, screws and nuts and wire products, stamping, etc., and lastly, the demand of our industry being so varied and small, no individual enterprise can stand the competition of the mass production.

Reply from (5) The Balance Works, Benares:

Hardware, viz., brass rods, pipes, sheets & wires, etc. and also screws and nuts and timber, glass, etc.

Purchases are made locally and from Calcutta and Bombay markets, etc. At present difficulties are felt in the purchase of imported raw materials mentioned above.

Reply from (7) Government Electric Factory, Bangalore:

(a) The important imported items of purchase consist of the following, being supplied from England:

(i) lenses;
(ii) Spirit Bubbles, of graduated type;
(iii) Aluminium Dial Rings and Prisms for Compass;
(iv) Brass hollow tubes.

(b) Other materials such as Brass castings, Brass Screws and Black Paint are readily available in the local market or in Bombay or Madras.

(c) The only difficulty is in getting imported semi-finished goods due to the incidence of war. There is no factory in India that can make lenses and bubbles.

Reply from (17) M. Ramchandra & Sons, Bombay:

The main raw materials required by us are sheets, pipes, plates, etc., of iron, steel, copper, brass and aluminium and other metals.

For manufacturing the articles we also require parts or semi-finished materials as under:—

(i) Pressure gauges for Auto-claves (English).

(ii) Thermometers for incubators, etc. (English and German).
(iii) Agate-Knives for Scales (English).
(iv) Electric Wires and other materials required for electric installation for incubators and Opthalmic Stands, etc.
(v) High Gear Driving Discs with brass collars and fixing screws for Sherrington-Starling Recording Drums (Eng.) etc., etc.

Reply from (20) Allibhoy Vallijee & Sons, Multan:

We use the following basic materials in our manufacture:

Steel tubes, angles, rounds, flat bars, sheets, and wire; tin, copper, brass and zinc sheets; stainless steel rods, tubes and sheets; paints and enamels; locks and sundry hardware goods; hospital glass and enamel wares, plate glasses, etc. etc., mostly obtained from India, England, U.S.A., and Germany.

The main difficulty we have to face is that most of the materials enumerated above are not produced in India to our standard and specifications, and we have to depend mostly on foreign countries for our requirements. Of course steel angles and sheets of Tata's manufacture are being utilized by us of the sizes and specifications at present manufactured by this concern. We are also using paints and enamels produced by a Calcutta firm of manufacturers. Locks are entirely of Indian manufacture conforming to our own specifications.

Reply from (23) The Laboratory Apparatus Works, Poona:

Indigenous raw materials:

For the manufacturing programme of electrical and optical instruments and apparatus, iron and brass castings are the only materials available. The little woodwork necessary for outside cases, etc., is manufactured locally.

Foreign raw materials:

General: Iron, steel and brass bars, round and square, strips and tubes of copper, brass and steel. Machine screws, brass and iron.
Ebonite, Vulcanite Asbestos and like materials. Finishing varnishes and colours.

Special: Silk covered copper, Manganine, Constantan wires, Nicrome and Eureca Resistance wires, bare phosphor Bronze, Invar, Advance strips,

Phosphor bronze and other fine wires and strips for galvanometer suspensions.

Achromatic objectives for telescopes and microscopes, eye pieces, magnifiers of different kinds, galvanometer mirrors, calc-spar and quartz optics, Magnets.

The foreign raw material thus comes to about 50% and Indian material is about 20%, of the cost of production.

Reply from (16) The Scales Mfg. & Adjusting Works, Bombay:

As regards raw and semi-finished materials we require plates, rods and wires of brass, copper, iron, steel, aluminium, German silver and zinc plates, tin plates, and galvanised plates. Most of these metals are imported from abroad except some iron and steel plates which can be had from indigenous sources. We also require plywood, teak wood and deal wood, of which plywood is imported from abroad.

As regards the supply of raw materials, we are not faced with great difficulty in normal times. But in war times, owing to enormous rise in prices, the cost of production of our articles correspondingly rises even though the prices have not gone proportionately high. This naturally has its effect upon the demand for our articles.

In the light of this information which has been supplied by the different manufacturers themselves, it is possible to enumerate the numerous types of raw materials that form the basis of this indusry.

wood: All kinds of wood, soft, hard, seasoned, multi-ply woods. Woods with definite properties, thermal, electrical, hygroscopic have special values. Except ply-wood all kinds are available of Indian origin.

Metals: All kinds of metals, iron, brass, copper, aluminium, zinc, tin in various shapes and sizes.

Sheets, rods, tubes, wires, are the raw materials for other semi-finished articles like nails, rivets, nuts, bolts, terminals, screws, etc.

Alloys of special composition like chrome-nickel, steels, phosphor bronze, German silver, manganin, etc., are required also in sheet, rod and wire forms.

Almost any metal is available for casting, but iron and steel are perhaps the only indigenous

metals; the rest are all foreign and the semi-raw materials are exclusively foreign.

Glass: For general purposes, tubing glass for blown glass ware.

Special chemical glass; soft, hard, pyrex, etc. Optical glass for the optical industry requiring lenses, mirrors, prisms, etc.

Raw material in this section is all foreign; only some quantities are now being attempted in Bombay, Calcutta and Bangalore. Optical glass is exclusively foreign.

Agate: For knives and buses, bearings, for mortars and pestles.

This is available in India, and the material can be dressed up in India in some factories.

Quartz: For crucibles, tubes, lamps, and optical instruments.

This material is all of foreign origin, although there appears to be no scarcity of quartz.

Wires: Bare and insulated of all kinds. Copper and various alloys for electrical, mechanical and musical instruments.

Nothing Indian in this line is available.

Strips: Metal strips, particularly of special alloys are extensively required for the preparation of control springs and suspensions and springs in general.

Nothing Indian in this line is available.

Asbestos: It is required in the form of sheets, threads and ropes and sometimes in loose form also.

These are all of foreign origin.

Emery and other Abrasives: These are all of foreign origin.

Paints, varnishes and enamels:

These are largely made in India, but not in sufficient quantity and of the required quality.

Ebonite: (in different forms) None Indian.

Bakelite and other Synthetic Plastics: None Indian.

Rubber: (in various forms) Raw rubber is of course Indian, but the finished products are largely of foreign manufacture.

Most manufacturers, at present, purchase these materials of foreign origin, and it should be the endeavour of the N.P.C. to foster the intensive production of these very essential raw materials, one by one. The manufacture of these materials is not legitimately the business of the scientific instrument maker, and he should, therefore, be able to purchase these in any desired quality and quantity in the local bazaar or get them done in the different manufacturing places in the country.

This is exactly the opinion voiced by one big manufacturing concern in Allahabad, as can be seen below:

> "It is necessary that there should be as in other countries, a happy co-operation between a series of co-ordinate industries. Further, the help and guidance of the scientific institutions should be available in directing the manufacturing processes in the right lines.
>
> For the sake of further elucidation a few industries may be suggested which might help the development of a scientific instrument trade in our country:
>
> (a) Fully developed glass industry manufacturing nothing but **tubings and rods**, and other mould blown glass apparatus.
>
> (b) **Alloy steel** and **non-ferrous manufactures** where the various forms and kinds of magnetic steel and alloy and bronze products necessary in the making of electrical meters and other measuring and indicating instruments.
>
> (c) **Stamping and rolling mills** and **Die casters**, where metal cases and different kinds of die stamping and various kinds of metal forms could be made. It is outside the practical possibility of any instrument manufacturer in the initial stage to possess the expensive metal stamping presses, dies, etc., and die casting machines. Besides the high cost of these plants the production is so great that no one manufacturer could efficiently avail of the large production.
>
> (d) There is no source of getting the supply of the various kinds of **screws, bolts and nuts**, etc., suitably at present. The manufacture of a few of these special and though at the same time most essential accessory in the making of the instrument line is outside the capacity of any individual scientific instruments maker at present."

It is thus possible to suggest that certain items should be picked out of the above list and existing manufacturers, scientists, Universities and other Research Institutions should be entrusted with the work of intense research in these branches. To give instances the following are mentioned:

1. Optical glass for lenses and prisms;
2. Special alloys for springs, magnets, resistant materials;
3. Synthetic resins;
4. Ebonite;
5. Mass production of nails, screws, nuts & bolts;
6. Tubes of brass and other metals;
7. Enamels—for cold and hot application;
8. Mass production of linear and circular scales;
9. Abrasives and grinding materials.
10. Soft glass for blown glassware; etc.,

It would be thus easy for the interested manufacturer to concentrate on developing the necessary technique in design and manufacture of a particular type of instrument rather than have to worry himself about the production of his essential raw and semi-finished materials.

It is recommended that the existing manufacturers would do well to co-ordinate their work, help to introduce specialization, follow co-operative methods of securing raw materials, make full use of the different investigating laboratories and Test Houses in the country.

CHAPTER V

LABOUR IN THIS INDUSTRY (SKILLED AND UNSKILLED) TRAINING ORGANISATIONS

Enquiries were made of the different manufacturers of scientific instruments in this country, by asking them the following questions:

The main difficulties you have to face in labour or power.

The replies received from them are given below:

Reply from (2) Hargolal & Sons, Ambala.

The labour is not skilled in the use of machinery work because there are very little organised efforts on the part of producers of materials in our line. There are no standard laboratories who could undertake the standardisation of the apparatus, and test the accuracy of the working of the instruments such as exist in Europe. In Europe high temperature furnaces are employed in the manufacture of apparatus. There are no arrangements in India for taking advantage of power, mainly because of lack of organisation and large scale factories.

Reply from (3) The Scientific Apparatus & Chemical Works Ltd. Agra.

We are facing the following difficulties and drawbacks:—

(a) For manufacturing Precision instruments we require some further Precision and Standard Machinery such as Milling Machines, Precision Lathes etc., which are not available in India. No Machinery is manufactured in India and hence we have to depend on the foreign countries even for a very small tool. The present Indian stocks are also not available as they have been kept reserved by the Government.

(b) As regards **Skilled Labour,** we beg to say that we require Mechanics of very precision hands, capable of doing the finest fittings by hand as well as on Machines. Such persons are rarely found and we have to train them at ours. Thus we have to waste a lot of money in labour and material. The same is the case with technical experts. There is no institution in India giving training of this type.

(c) We further beg to draw your kind attention to the fact that there is very great necessity for having an Institution for grading and standardisation just like the National Physical Laboratory of England which can test our Precision and High Class instruments. We have to depend upon our own standards though the Instruments manufactured by us meet the requirements of Universities and Research Laboratories.

Reply from (4) The Scientific Instrument Co., Ltd. Allahabad.

The consumption in our line of trade as indicated above is so small that it is unremunerative to take advantage of the modern precision and automatic machines and tools. These are very costly and the production is so great that no one manufacturer could keep these engaged reasonably to make his investments in these expensive machines profitable; consequently we have to fall back upon our present resources of manual labour and coarse tools, hence our present turn-out lacks that precision and finish generally expected in Scientific Instruments.

In foreign countries most of the small instrument manufacturers have only assembly plants, getting all the other work and materials from the big and specialised industries. Further they get the advantage and co-operation of the various scientific laboratories and research insitutions to work out any problems and solve any particular difficulties which are outside the capacity of the small manufacturer. Some of the Universities in our country nowadays possess and maintain expensive machines and tools, e.g. circular and linear graduating machines, glass and lens, grinding forms and tools, and perhaps these are not fully utilised. If their use is made available on reasonable charges the production of some of the most intricate and expensive instruments could be helped to a great extent.

Another great handicap now faced by our industry is the paucity of **skilled mechanics and labour.** It is a difficult task known to all those already in the trade what amount of money, time and trouble one has to risk over our unwilling, impatient and inefficient so called skilled hands, in order to make them really efficient mechanics who have a real sense of precision and quickness of turnover. **The existing technical institutions, to our mind, fail to impress on the students' sense of precision and finish** which is so essential in all training of any skilled labour. Small manufacturers obviously cannot stand or risk the expensive

outlay to secure really good skilled mechanics, even though they happen to possess costly tools and machines.

Reply from (5) The Balance Works, Benares.

Purchases are made locally and from Calcutta and Bombay markets etc. At present feeling difficulties in the purchase of imported raw materials mentioned above.

Reply from (7) Government Electric Factory, Bangalore.

The only difficulty is in getting imported semi-finished goods due to the incidence of war. There is no Factory in India that can make lenses and bubbles.

We have no difficulty with regard to labour and power.

Reply from (7) M. Ramchandra & Sons, Bombay.

The paramount difficulty we have to face in our industry is as regards labour. Owing to our limited capital we cannot manufacture the articles in big numbers either for stock or for market. We manufacture articles only on orders. Hence the amount of labour required is very high, inasmuch as we manufacture even the smallest parts of the articles. Moreover, we experience a great difficulty in getting workmen specially trained in this industry. This business is not so paying to us as it ought to be, owing to the fact that we have to popularise our articles by selling them at proportionately too low prices compared with those of foreign articles. In normal times we do not find much difficulty in getting materials required for our industry. Our workshop is run on electricity and there is no difficulty as regards power etc.

Reply from (23) The Laboratory Apparatus Works, Poona.

It should be noted that the above manufacturing programme is rather ambitious. If a reasonably good number of copies of each are to be turned out every year, the present small workshop will have to be increased to several times its present magnitude. There are at present very few good machine tools and a few good workmen trained. What could be achieved by the proper kind of special machine tool, is now being accomplished in a roundabout manner. To do the job thoroughly, precision machine tools like Lathes, Shapers, Milling Machines, Polishers, Grinding Machines, Dividing Machines for circular and linear divisions, Electric Welding Machines and the like are necessary. Even if the manufacturer limits his ambition to one

good machine of each type, the amount to be invested will be more than Rs. 50,000.

In addition to the machine tools a good and choice collection of tools for gauging and precision measurements will be necessary.

The establishment and conduct of a small laboratory and several test rooms will be necessary. The real necessity for such a thing lies in making experiments with a view to manufacture what one imports at present. To give an example, for the complete manufacture of optical instruments, it is wrong for ever to depend for the optics on a foreign country howsoever efficient in the supply of such commodities. The precision grinding and polishing of achromatic objectives must be mastered sooner or later.

Labour

Skilled mechanics for the jobs in an Instrument Shop must be specially trained. Training in fine mechanics is a thing unknown in India. Possibly the Postal Workshops at Alipore only train a few people for fine turning or milling. Each shop will have to train its own people. If matriculates with a mechanical and scientific bias are available these should be trained if they assure to serve for at least 10 years the shop where they have been trained. Side by side with training, Physics, Chemistry, and Mathematics of the Intermediate standard should be taught to these. The extent to which enthusiastic Science Graduates are able to take up such manufacture as a labour of love can be availed of. In the initial stages at least such people will have to work on a living wage basis. Mere skilled mechanics will not be enough for the manufacture of quality instruments. There must be a science man associated with it having more than a wage interest in it.

Supervision and testing

For supervision and Testing the most suitable persons will be those who have passed the M.Sc. of any University. But it should be borne in mind that a person quite fresh from the University will not be able to immediately direct and supervise an instrument shop. But the above academic qualification will enable him to locate defects and think of the remedies if he sets about the job with a strong and persistent will.

Reply from (16) The Scales Manufacturing & Adjusting Works, Bombay.

Our industry requires **skilled labour** which has got to be trained from the beginning. We have not experienced

as yet any labour trouble. This is due to the fact that the grades of salaries in our workshop are determined by the merit of the workmen and also because of the reasonable treatment meted out to them.

It can be seen, from the above, that the question of skilled labour is a very important one and unfortunately it does not seem to have caught the necessary attention of Technical Institutions, Universities and other large manufacturing establishments. As mentioned already, one instrument maker is of the opinion that the University trained man lacks the precision. If this be taken to be true in its entirety, its cause is not far to seek. There is a wide gulf which separates the training that a young man gets in a technical institution and the actual work that he has to do in his employer's workshop.

There are certain facilities for the training of the necessary labour, but most of them are only an indirect approach to the requirements. They are very much academic and do not concern themselves directly with the task of training the youth with the object of making them intelligent instrument-makers. The facilities that are available in actual workshops and manufacturing places are certainly better in the sense that they make the workman precision-minded. But there is one other drawback usually noticed in such places. The recruits have initially little or practically no theoretical background and there is also no provision to give them this basic education.

Arrangements should be made whereby a young boy soon after the completion of his middle school education should be apprenticed to an industrial institution where he can receive side by side adequate training—

(i) in the profession,
(ii) in the economics of the industry,
(iii) in the cultural background of this country.

Schools with a vocational bias, technical schools and larger engineering institutions conducted by private bodies or Government will fall short of the actual requirements. The proper training centres are the works themselves and it should be possible to entertain a certain number of select young pupils as apprentices to be regularly trained for the instrument-maker's profession. All types of people have a place in this industry,—foundry-men, carpenters, painters, designers, metal-workers and machanics, testers, etc. There is room for young people with elementary training; there is also room for persons with the highest academic qualification as designers and researchers.

An expert committee consisting of eminent instrument-makers, educationists, and Government representatives of Industry should be called upon to go into the question thoroughly. In the meanwhile some such plan, as indicated below, should be adopted:

For the supply of skilled labour in Instrument making, it is essential to start training centres in fine mechanics and laboratory arts. After a general training the men must be absorbed as apprentices in Instrument making shops on contract basis, care being taken to so formulate the contract that the interests of both the manufacturer and the labourer are safeguarded. Special care will have to be taken to see that migration of trained skilled labour due to employer's tricks are prevented.

Skilled labour of the higher type involving initiative has to be acquired by sending abroad properly equipped and trained youths of the country for the purpose.

The Universities and other public institutions which maintain large libraries will also have to widen the scope of their activities and endeavour to obtain literature bearing on the subject of the manufacture of scientific instruments, a subject which appears not to have received much attention so far. It is probably for the first time that this subject is included among the larger organisations of national importance.

CHAPTER VI.

MACHINERY AND MACHINE TOOLS

It is not generally realised by most people in India that even in foreign countries most of the manufacturers of scientific instruments, are for the major part, large assembly plants. They obtain all their materials in the form of completely prepared components of definite specifications from other larger industries which specialise in such manufacture. But it must be remembered that even the semi-finished or completely finished components are produced in the same country. Nails, nuts, bolts, screws for metal and for wood are typical illustrations of the basic components on which a scientific instrument maker can lay the foundation of his work. Rods, tubes, plates of all possible shapes and sizes and of all possible metals and alloys are raw materials for the scientific instrument in this country. This is very unfortunate but unavoidable since he is, for the most part, unable to secure adequately and cheaply the necessary supply of a variety of components. He is usually constrained to build them all for himself, by going through all the operations, choosing the most suitable raw materials, casting, turning, finishing, testing and so on.

This is obviously a very wasteful procedure, because the elementary components required by an instrument maker are large in variety but small in numbers. He cannot afford to possess economically the necessary machinery to prepare them. There should be, therefore, a more or less clear cut separation in this respect viz., (i) mass production of the necessary components and (ii) the assembly into a scientific instrument according to requirements. Some works should concentrate on the manufacture of essential components in the form of nuts, bolts, screws, washers, rivets, nails, tubes, rods, plates and so on. They would be producing on a mass scale and be able to serve the whole country and all manufacturers of different kinds of instruments. This arrangement, when evolved, will enable the instrument maker to concentrate his time, money and attention on design, assembly and quality. Occasions will arise when he would find it necessary to employ a particular type of elementary component on a

large scale. Yet the scale would not be large enough to warrant his manufacturing of that special component for himself. It would need the purchase of special machinery. He may sometimes have the necessary money to buy the machinery, but he would, by himself, certainly not have enough work for the same to keep it active to be economical. Special types of toothed-wheels, watch springs, jewel-bearings, circular and linear scales, etc., are instances of such requirements. Most of them can be made with the hand; but they are much better made with standard automatic machinery, using special tools and working with very high precision.

The tools of the assembly type are those that are usually available in a carpenter's or metal worker's shop, including lathes, drilling and punching machines, planing and sawing machines, forges, grinders, etc. These are, no doubt, obtainable without any difficulty, but they are all of foreign make.

(i) Chisels, plane cutters, lathe tools, simple kinds of drill bits, can be conveniently forged in this country by skilled blacksmiths. But the quality tool-steel is not made in this country. Attention of the metallurgists should be pointedly directed to this important problem.

(ii) Saw blades, files, twisted drill-bits are the most elementary tools required in enormous quantities and the production of these in this country would be a great national asset.

(iii) Lathes, drilling machines, shaftings, bearings, punches, presses, wire-pullers, ribbon-makers (roller presses) can all be made in this country by merely copying the existing models, after the necessary alterations have been carefully thought out. But this would be work in itself for the big machine industry.

(iv) Casting and moulding establishments, welding workshops, electro-plating plants, are important items but they are of such a nature that the usual scientific instruments maker will not like to and, in fact, would not be competent to, get mixed up in them. They would normally be outside the scope of his activities. The instrument maker should be in a position to depend reliably on getting an adequate, prompt and cheap supply of facilities that are available in the above mentioned institutions.

(v) Stamping, rolling mills, die-casters, where metal cases and different kinds of die-stamping, wire and ribbon drawings are carried out, are also appliances which must lie outside the practical ability of a single instrument-

maker. These tools, along with those mentioned in (iv) are, no doubt, useful but very expensive to buy. Further they need an enormous amount of work output to keep them busy. If they have not enough work and if they are not kept occupied, they prove to be very uneconomical and in a few years they also become out-of-date. Continuous improvements are going on in this kind of mass-producing machinery. Special large scale manufacturers can undertake this kind of work. They can produce the elementary components and sell them to the smaller instrument makers.

(vi) Precision machinery: In the manufacture of scientific instruments, in general, and the measuring instruments, in particular, it is quite essential to use Precision and standard machinery. Lathes, shapers, milling machines, polishers, grinding machines, dividing machines for circular and linear scales, have all to be of the precision type if the manufactured scientific instrument is to possess any high precision.

These kinds of precision machinery are very expensive. The consumption, at present, in scientific instruments of Indian manufacture is so small that it becomes altogether unremunerative to take advantage of the modern precision and high speed automatic machines and tools. No single manufacturer can buy them and even if he has the money to buy them he cannot keep them engaged reasonably to make his investments in these expensive machines profitable. Consequently, the Indian scientific instrument maker falls back upon his usual resources of manual labour and coarse tools. If the finish and degree of precision is not high in instruments of Indian manufacture, the main cause is to be sought in this lack of precision and machine tools.

There is such machinery available in India in some large workshops under the control of private and public technical institutions and workshops. Some Government workshops are also excellently equipped. It is recommended that some scheme could be worked out whereby use could be made of the facilities existing already. Use can be made for the training of precision machines and for the production of special articles, with the permission of those institutions that possess the equipment.

It is also suggested that at each provincial centre there should be a museum containing the essential special small tools and precision machines in working order. This should serve the double object of demonstrating to the manufac-

turer the particular machines in working condition and enabling the manufacturer to get some special parts for his instruments manufactured by his own mechanic. Later on when the demand justifies, the manufacturer will equip his workshop with the right type of machine.

The different manufactures of scientific instruments in India produce numerous articles; and although only few of them undertake to produce instruments of a specialised nature, it must be admitted that they all do their work with an enthusiasm which is characteristic of their profession and their products are on the whole satisfactory. What is important is to realise that the necessary intelligence, experience and skill exist in India. It needs, however, a special effort on the part of the Government and the public to give the necessary encouragement to this unique branch of public utility, viz., the trade of manufacturing scientific instruments.

CHAPTER VII

STANDARDISING INSTITUTIONS AND INDUSTRIAL RESEARCH ORGANISATIONS

The scope of this chapter is very extensive, because Standardising Institutions and Industrial Research Laboratories are considered essential in the successful manufacture of scientific instruments.

In foreign countries such institutions are established and maintained by Governments and they work hand in hand with the different manufacturing industries of the country. They also work under one single co-ordinating authority. (1) It is the business of these institutions to fix up primary standards and derive practical standards. (2) These institutions systematically get into contact with the problems of the different industries and services that employ scientific instruments, for purposes of production, control and measurement, with a view to render adequate technical assistance and advice. (3) These institutions can supply the necessary technical information from all available sources of literature and experience. (4) They can undertake investigations of different kinds of raw materials, examine designs and plans and make necessary recommendations. (5) It is also a function of these establishments to test and grade the various kinds of manufactured components and complete instruments as regards their utility, cost, precision, efficiency and so forth.

The information given in this chapter, therefore, naturally divides itself into four major heads:—

(i) **Introduction** which deals with the fundamental standards of length, mass and time, and their measurements in the different conventional systems. An account of the historical background is also given.

(ii) Items of **Standardization Organisation** containing descriptions of the various kinds of derived standards employed in practice.

(iii) **Standardising Institutions** which work in different fields in the form of Board of Trade, the Department of Scientific and Industrial Research, the National Physical Laboratory, etc.

(iv) A plan for the formation of a **Central Council of Standardization** for the whole of India with provincial

standardizing Laboratories containing departments equipped to investigate the peculiar needs of the province.

(i) Introduction

In the early stages of social development the need for some standard regarding the measurement of length evidently arose in connection with the reckoning of distances as well as that of measurement of land and habitations. One, therefore, finds in all the countries of the world even in the earliest times an attempt to fix some standard of length. The pre-historic remains discovered by archaeologists and the various architectural monuments in different parts of the world leave no doubt that a system of length measurements was introduced as the social structure of any country became developed.

With the gradual development of the society, trade and commercial relations between different parts of the same country, as well as different countries of the world, necessitated the introduction of standards of length as well as that of mass and time. There is ample evidence of international trade relations between India and other countries of the world and as such **these standards were more or less determined in India and accepted by other nations** with the growth of commercial intercourse. In fixing up a standard for these fundamental units one cannot, therefore, neglect the historical background on which the present standards have been based, and also to consider carefully their adoption in the 'National Planning' of our country.

To begin with, a brief account of the measurements of length, mass and time as adopted in India in ancient times would be of some interest. L. D. Barnett in his "Antiquities of India", Chapter VII, has collected the various units of length, mass and time measurements as found in ancient sanskrit books.

MEASUREMENT OF LENGTH (FOR FINE MEASUREMENT)

In Markandeya Purana.

8 javas	= 1 angula	8 paramanus	= 1 para-sukshma
6 angulas	= 1 padas (foot)	8 para-sukshmas	= 1 trasarenu (mote)
2 padas	= 1 vitasti (span)	8 trasarenu	= 1 renu or Mahirajas (sand-grain)
2 vitasties	= 1 hasta (cubit)	8 renus	= 1 valagra (tip of hair)
4 hastas	= 1 danda (rod or dhanus)	8 valagras	= 1 liksha (nit)
2 dandas	= 1 nadis (reed)	8 likshas	= 1 yuka (louse)
2000 „	= 1 gavyuti	8 yukus	= 1 java.
8000 „	= 1 yojana.		

Mahā-vīra in his Ganita-Sāra-Sangraha gives practically the same scheme with some little alterations. Thus:

8 anus	= 1 trasarenu
8 trasarenus	= 1 ratharenu
8 ratharenus	= 1 hair (English word)
8 hairs	= 1 liksha
8 likshas	= 1 tila (seasame seed) or sarshapa (mustard seed).
8 tilas	= 1 java.
2000 dandas	= 1 krosa
4 krosas	= 1 yojana.

In Kautilīya-artha-sāstra, one finds very similar measurments, Brahamānda-purāna and Vāyu-purāna give the scheme in a slightly different fashion, viz.,

10 angulas	= 1 pradesa
12 ,,	= 1 vitasti
21 ,,	= 1 ratni
24 ,,	= 1 hasta
42 ,,	= 1 kishku
4 hastas	= 1 dhanus, danda, nalika or yuga.
2000 dhanus	= 1 gavyuti
8000 ,,	= 1 yojana.

It is rather interesting to note that some of these measurements still persist even in the villages of modern India but the foot-scale and the yard measure either in the form of tape or in the form of ruler have been fast displacing the older type of measurements and a system of uniform standard is getting introduced.

The Manu-smriti and Yājnāvalkya-smriti give the following table of weights for ordinary commodities.

The Measurement of Mass

8 trasarenus	= 1 liksha (nit)
8 likshas	= 1 raja-sarshapa (black mustard seed)
3 raja-sarshapas	= 1 gaura-sarshapa (white mustard)
6 gaura-sarshapas	= 1 yava (middle-sized barley corn)
3 yavas	= 1 krishnala or raktika (seed of the gunja or Agrus precatorius)
5 krishnalas or raktikas	= 1 masha (bean)
16 mashas	= 1 karsha, aksha, tolaka, or suvarna.
4 suvarnas	= 1 pala or nishka
10 palas	= 1 dharana of gold
2 krishnalas or raktikas	= 1 masha
16 mashas	= 1 dharana or purana
10 dharanas	= 1 sataman (palan).

There are other systems relating to food-stuffs medicine, precious metals and stones.

The Measurement of Time

Time reckoning was based on astronomical observations of which there are a number of important treatises, and for,

the regulation of festivals and rituals an elaborate system was evolved.

Thus in Manu-smriti,

1 ahoratra	= 30 muhurtas	15 ahoratra	= 1 paksha
1 muhurta	= 30 kalas	2 pakshas	= 1 month
1 kala	= 30 kashtahas	2 months	= 1 ritu (season)
1 kashthas	= 18 nimeshas	3 ritus	= 1 ayana or half solar year.

There is also sub-division of a day,
1 day = 4 praharas or yama.

and a further sub-division of praharas into dandas, palas, vipalas and anupalas.

Moghul Empire in India introduced new standards of length, mass and time for the purpose of land settlement, furtherance of trade relations, revenue adjustments and administrative functions. From Ayeni—Akbery, (Edition by F. Galdwin) one finds that three kinds of yards **(Guz)** were prevalent in the country. Long, Middling and Short and each was divided into 24 equal parts called Tesuj. A tesuj of the long **guz** was equal to the breadth of 8 ordinary barley corns. The **long guz** was used for measuring cultivated lands, roads, forts, reservoirs and mud-walls. The **middling guz** served for measuring buildings, (stone and wood), thatched houses, religious houses, wells and gardens, armour, etc. The **short guz** was now employed for measuring cloth, armour, beds, palkis, chairs, carts, etc., and the Tesuj was further divided into a number of smaller divisions. During the reign of Sultan Secunder Lodee, a **guz** was introduced consisting of the breadth of 41½ Iscunderees (a round silver coin adulterated with copper). Humayun made it complete 42 Iscunderees. This **guz** is equal to 32 fingers. Till the 31st year of the reign of Akbar, this **guz** was employed normally for measurements excepting the measuerment of cloth which was **guz** of 46 fingers. Akbar abolished all other measures and introduced the "Ilahee Guz" of 42 fingers and this was employed by his officers in the survey and settlement all over India. The finger was the measure of the width of 3 round barley corns. In order to secure a uniform standard "agate barley corns" were prepared under the orders of the Emperor and engraved with the imperial mark and distributed to the different centres.

In the measurement of mass, the current coin **tola,** was the unit from which the different units of seer and maunds

were derived. The measurement of time was also modified after due consideration of the old calendars, viz., the Hindu as well as the ancient Persian systems.

Though these units were introduced by Emperor Akbar for the administration of the different provinces, different cities had different types of standards for mass and length, some of which were based on the old Hindu system.

The introduction of the British rule in India led to the gradual adoption of the British units in commercial cities. Though the elaborate survey system of the British India and Indian States have been based upon British units still at the present moment there are a number of other units prevalent. As an example, one can refer to the length measure of the tailors and the dealers of piece goods. Here, yard is sub-divided into 16 parts and each part is known as **"girah".**

The present system of weights and measures in India varies not only from district to district but also for different commodities. The principal units of all scales of weights at present are "tola", "seer" and "maund" and the standard adopted for them compared to the British unit are as follows:—

tola = 180 grains (troy)
seer = 2.057 lb.
maund = 82.28 lbs. = 40 seers.

It may be pointed out in this connection that the unit adopted for the "tola" is the same weight as the current coin rupee which is 180 grains troy, and 80 tolas is equal to the "standard or railway seer" and the standard of railway maund is 40 seers, that is 82 lbs. 4 oz. 9 dram.

In reckoning the standard for these fundamental units one should consider all the factors that are prevalent in the country as well as realise the importance of the British and Metric units which have been standardised in Europe and America; and it will be worthwhile in this connection to have a clear idea of the historical development of these two systems of measurements, viz., the British and the Metric. They are so firmly established that both have to be fully considered in any general discussion of the subject while all others fade into comparative insignificance and have at the most local and historical interest.

The British Unit

The British is of greater antiquity and, with some changes, but with no violent alterations, have practically come down from the Roman times. The fundamental

standard of length in the British system is the Yard, a length which has been preserved almost unchanged since the days of Edward I. Various attempts at legislation to enforce the use of uniform standards of length have been made in almost every country from the very earliest times. The importance of such uniformity in commercial intercourse is obvious. Such legislation has occurred in England prior to the reign of Edward I. The inch, the foot (derived from the Roman foot), the cubit (18 inches) and the "Ulna" which was the predecessor of the yard and which gave its name to the yard of Edward I, were all existent before. The effect of the act of Edward I was to correlate and unify these various pre-existent measures and the important clauses translated from Latin read as follows:—

> "It is ordained that three grains of barley dry and round, make an inch; 12 inches make a foot; 3 feet make an ulna; 5½ ulna makes a perch and 40 perches in length and 4 perches in breadth make an acre. And it is to be remembered that the iron ulna of our Lord the King contains 3 feet and no more; and the foot must contain 12 inches measured by the correct measure of this ulna, that is to say 36th part of the said ulna makes 1 inch and 5½ ulna or 16½ feet make 1 perch in accordance with the above iron ulna of our Lord the King."

Unfortunately, the actual standard bar created by Edward I has been lost and the earliest authentic standard is the brass yard of Henry VII, now preserved in the Standards Department of the Board of Trade, London.

An Act of George IV passed in 1824, repealed all the laws on the subject enacted since the time of Edward I, and ordained that all measures of length were to be based upon a standard yard which had been constructed by a parliamentary committee in 1758, which in future was to be called the Imperial Standard Yard. The yard constructed by the parliamentary committee of 1758 and legalised by the Act of 1824 was based on a brass yard made by the order of Queen Elizabeth in 1587 which is also preserved at the Board of Trade and which agrees with the present yard within 0.01 of an inch. The yard of Henry VII differs from the present legal standard by 0.037 inch.

The present legal standards were constructed after the destruction of London by fire in 1834. A very careful study was made by a Committee of all the available copies of the lost standard. The question of accurate temperature cor-

rection during the time of measurement was gone into and the Committee decided to safeguard against future loss by duplicating the standards and causing copies known as "Parliamentary Copies" to be deposited in safe custody with various responsible bodies. These copies were carefully compared with the Imperial Standard preserved in the Office of the Exchequer so that small inevitable errors are known, and were deposited in 1854 (1) in the House of Parliament; (2) at the Royal Observatory, Greenwich; (3) at the Royal Mint; and (4) with the Royal Society. These Parliamentary Copies constitute the secondary standards of British system and are required by law to be inter-composed once every 10 years and to be compared with the Imperial standard once every 20 years. An Act of 1866 transferred the custody of the Imperial Standards from the Comptroller General of the Exchequer to the Board of Trade.

The Imperial Standard for determining the length of the Imperial Standard Yard is a solid square bar 38 inches long and 1 square inch in transverse section, the bar being of bronze or gun-metal; near to each end a cylindrical hole is sunk (the distance between the centres of two holes being 36 inches) to the depth of $\frac{1}{2}$ inch; at the bottom of this hole is inserted in a smaller hole a gold plug or pin about 1/10th of an inch in diamelincand upon the surface of this pin there are cut three fine lines at intervals of about 100th part of an inch transverse to the axis of the bar and two lines at nearly the same interval parallel to the axis; the measure of the length of the imperial standard yard is given by the interval between the middle transversal line at one end and the middle transversal line at the other end, the part of each line which is employed being the point mid-way between the longitudinal lines and the said points are in this Act referred to as the centres of the said gold plugs or pins. No. 1 standard is made of Baily's metal—copper 16 oz. tin $2\frac{1}{2}$, zinc 1, cast in 1845. No. 1 standard yard is to be reckoned at 62.00 degrees Fahrenheit.

The Metric Unit

The history of Metric system commences from the time of French Revolution (1792). The standard of length in this system is **Metre** which was originally intended to be one-ten-millionth part of the quadrant of the earth's meridian. The measurement of the meridian was made in terms of the old French measure, the "Toise", and from this determination with very high precision it was found

that the Metre should be 0.53174 toise. The original "Metre des Archives of France" was constructed on this basis and consisted of a flat bar of platinum 25 mm. wide, 4 mm. thick, the metre being defined as the distance between the centres of the end phases of this bar at the temperature of melting ice. This remained as such until 1889. Representations made in 1867 and 1869 by the Conference of the Geodetic Association and by the Academy of Science, St. Petersburg, led to the appointment in 1870 of the International Metric Commission which in 1872 reported in favour of replacing French Metric standard by new international standards which should preserve as far as possible the values of the standards of the "Archives of France" and of the formation of an International Bureau of Weights and Measures and made detailed proposals as to the character of new standards and the methods to be added in preparing them. In 1875 effect was given to these proposals by the signatories at Paris of the "Convention du Metre" by which the Governments of various contracting States undertook to maintain at common expense a permanent "International Bureau" for the purpose mentioned. This Bureau is actually housed at the Pavillon de Bretuil, Sevre, near Pais, and is controlled by an International Committee acting under the general instruction of a General Conference which meets once in six years.

The new International prototype standards were completed in the year 1882 and, after elaborate comparisons, were both declared identical within the limits of error of measurements with the original standards of the Archives. The intercomparison of the national copies of new standards with the prototypes, and with each other occupied another 7 years and in 1889 these were accepted by the Conference and distributed by lots to the various nations signatory to the convention. Two standards of each type were also selected to serve as secondary standards i.e. to act as controls on the prototypes or to afford the basis for replacement if ever required.

Measurement of Mass

The measurement of mass which is the second standard has to be considered now. Here also the dual system of the British and the Metric are being used side by side in the different countries of the world and a small historical survey is worth our attention. Taking the **British** standard we find that:—

The fundamental standard of the British Imperial System is the "pound avoirdupois" which is defined as the

mass of a certain cylinder of pure platinum about 1.35 inches high and 1.15 inches in diam., with a groove round it about 0.34 inch from the top for insertion of the prongs of an ivory fork by which it is to be lifted and all edges carefully rounded off, marked PS 1844. 1 lb. and now preserved at the Standards Department of the Board of Trade, 6 Old Palace Yard, Westminster.

The present **Imperial Standard Pound** was prepared, not from a previously existing standard but from certain authenticated copies of the old brass troy pound of 1758 which upto the time of destruction by fire in 1834 occupied the position of principal standard (H. W. Miller, Phil. Trans. 1856, CXLVI).

As with the yard, the Parliamentary copies of the **Imperial Standard Pound** have been deposited at the Royal Mint, at the Royal Observatory, Greenwich and with the Royal Society and one immured in the new palace of Westminister. In the work of reproducing the standard, a number of weights were available (2 of platinum, 6 of brass) and the act legalising the use of this standard proceeds: "It shall be the legal and genuine standard measure of weights and shall be denominated **"Imperial Standard Pound Avoirdupois"** and shall be deemed to be the only standard measure of weight and other measures having reference to weight shall be derived, computed and ascertained, and one equal 700th part of such pound shall be a grain and 5760 such grains shall be deemed to be a pound-troy".

These weights were recompared in 1844 and it appeared evident that the brass weights had gained in mass as compared with the two platinum ones which relatively remained unchanged by amounts varying from 0.009 to 0.023 of a grain. It was found possible to re-establish the weight of the standard in air to an accuracy of 0.001 to 0.002 grain, that is, 1 part in 5,00,000.

Copies of the new standards were sent to the principal countries of the world including the United States of America in which the British System of weights and measures still is the legal standard.

The Metric System

The primary standard of mass on the Metric system is hte International prototype Kilogramme which is a simple cylinder of platinum-iridium alloy (10% iridium) of approximately equal height and diameter deposited at the "Bureau International des Poids et Measures", Sevres. It was

found identical in mass, within the limits of observational error, with its predecessor "Kilogramme des Archives of France."

Two copies of it are preserved as secondary standard while further copies have been distributed for use as national standards to the various states signatory to the "Convention due Metre" of 1889.

It would be interesting to compare here the conversion factor of the British system of length and mass with that of the Metric and it is found as follows:—

1 metre = 39.370113 inches; 1 inch = 2.54 centimeters.
1 kilogramme = 2.2046223 lbs. (avoir).

In this connection, it would not be out of place to point out that since the year 1897 (under the provision of weights and measures Act, 1897) the use of Metric system has been legal for all purposes of trade. Metric denominations of weights and measures were legalised by an order in Council dated the 19th, May, 1898; and by an order in council of the same, date tables of equivalence of Imperial Weights and measures in terms of Metric System were duly issued and by an order of the Council dated the 14th October new denominations of weight of Metric carat of 200 mg. and its multiples and sub-multiples were also authorised for use in trade. Such procedure mainly arose out of the different nationalities on the continent using the Metric system and it was soon apparent that the Metric system gradually prevailed over the other systems due to ease in calculation as well as the following considerations:—

(a) That the definition of the standard of length by means of a measurement taken at the melting point of ice renders the standard independent of errors in the temperature scale, and is, therefore, intrinsically more reliable than a definition at 62°F., which involves thermometric measurements.

(b) That the material of construction of the British standard has not proved completely stable, and that there is, therefore, a doubt as to the permanence of the standard and whether it still represents accurately its original value.

(c) That the true kilogramme being (approximately the mass of a cubic decimetre of distilled water at its temperature of maximum density affords a logical basis for the unit of mass and one which is of great convenience in chemical computations.)

(d) That the multiplicity of subsidiary standards and the variability of the factors employed on the British sys-

tem for forming multiples and sub-multiples of standards, are highly inconvenient, and constitute an unnecessary educational stumbling block, contrasted with which the employment of decimal scales of multiples and sub-multiples greatly facilitate computations of all kinds.

(e) That the system has received international sanction, is already legally obligatory in many countries and optionally legal in many others, and, therefore, forms a proper basis for an eventual world system of standards.

The Measurement of Time

The next fundamental unit is that of time. It enters as an element in all natural events even more universally than do space and mass but whereas different lengths and masses may be compared under proper precautions with the same identical fiducial standards the Warden of the Standards is unable to produce a standard hour or minute for verification; and time can only be measured by the repetition of a process. The measurement is, therefore, bound up with the theory of process selected and is liable to adjustment should the theory be varied. The main process obviously presented as suitable and convenient is the rotation of the earth. Apart from the rotation of the earth natural clocks offered by astronomy are the revolutions of the moon and the planets. All these are deeply involved with difficulties of theory or observation and can only be used as a last resort for confirmation of suspected changes.

Rotation of the earth is an extremely good standard of uniform motion but not a perfect one. Contraction of body must accelerate, and tidal friction must retard it. Both act continuously in one sense and therefore cannot be negligible. Without going too far into astronomical details it may be said that the effect of variation can now be identified pretty certainly with residual terms showing themselves as an apparent displacement of the moon and of the planets otherwise unexplained.

In defining the rotation of the earth one has to be clear about the fixity of direction. This is a delicate and elaborate process. The direction of very remote stars can be taken as absolutely fixed and their distances are so great that in the absolute sense there would hardly be any sensible deviation. For the brighter and less distant stars on which daily observations must depend, astronomical observations indicate that these show systematic motion in streams, so that an origin of direction based upon a stream to which sun did not belong would be a moving origin. The

amount of variation is such that in the duration of a century, the correction would be the fraction of a second. In practice there is a list of stars, made after full discussion, showing the positions of each relative to the mass. A full observation for time in an Observatory rests on the mean of the determination of the moment of passage of, say, about 10 of these stars across a local meridian, and this must reasonably be expected to be reliable within 0.01 seconds. In reality, the individual observations depend upon the discrepancy which has to be shared between the clock with which they are compared, the chronographic system of recording its indication, faults in measuring the position of the telescope with respect to the meridian and the horizon, personal equation of the observers and finally to deviations of stars from their mean places due to atmospheric causes. The uncertainty of testing the going of a clock, inasmuch as its errors cannot be assigned with certainty, within 0.05 second on any given day, owing to weather sometimes going undetermined for many days together.

The first standard of time is the **Sidereal day** reckoned from the zero of the star catalogues. The time of one Sidereal day is made up of 24 hours.

Mean solar time upon which all civil work depends is never determined directly but is calculated from the observed Sidereal time. The correlation is made with the help of theory and tables of the sun due to Newcombe. These tables give the position of an imaginary body called the apparent mean sun with respect to the first point of Aries, the zero of the star catalogue. Just as the first point of Aries provides the Sidereal time at any place so the apparent mean sun gives the local mean time. For daily use the position of the mean sun with respect to the first point of Aries is shown in the Nautical Almanac. The Mean Solar day is divided into hours, minutes and seconds similar to the Sidereal day, and since a tropical year consists of 365.2422 mean solar days and the same interval is reckoned as 366.2422 Sidereal days, it would follow that:

1 sidereal days 23 h. 56 m. 4.08 s. (solar).
1 mean solar day 24 h. 3 m. 56.46 s. (sidereal).

Basing upon Greenwich as the prime or zero meridian the world is partitioned by convention into zones of 1 hour or half hour in width at the margins uniting which one finds the mean time. The observatories of Paris and Edinburgh, use the mean time of Greenwich allowing the respective longitudinal differences from the Greenwich meri-

dian. The observatory of Washington follows the same process but allows a further 5 hours for the difference of zone. The world time zone chart published by the Admiralty shows how the boundaries of time zones on land as well as on sea are marked in different national or provincial boundaries.

The practical determination of the time, therefore, is dependent on astronomical observations on the one hand and reckoning of the instants of transits with the help of clocks and thus in the determination of time the accuracy of the moving system of a clock is one of very important consideration.

It would not be necessary to go into the detailed history showing the evolution of the present system of chronometers and chronographs but it has to be pointed out that in all the modern observatories, one finds standard chronometers whose performances have been under regular observation over a long period.

The present system of radio broadcasting by the different nationalities has gone a long way to solve the problem of time determinations in the different countries of the world, also for the ships travelling on the ocean in different quarters of the globe.

II. ITEMS OF STANDARDISATION — ORGANISATION

The introduction briefly indicates how the three fundamental standards of length, mass and time prevailed in India in the past and as it has been evolved in the different Western countries. Of the Eastern countries, Japan is the member of the International Commission and as such it has the advantage of the International Bureau of Standards for the determination of these primary standards. China is not yet a member of the Commission.

For world sea-borne trade these three fundamental standards have been used for a long time. **India is not a member of the International Commission and as such the prototype standards are not available in this country.** The standards of length, however, are maintained by the Surveyor General of India and the standard of mass (British standard) is kept by the different Mints and the time standards are maintained by the different Meteorological and other observatories.

Besides these three fundamental standards, one has to consider the **Derived Standards.** These derived standards are of great importance not only in the trade but also in the social system of any country. Thus one has got to

consider the standardisation of tapes and chain links which are multiples of the yard and the derivation of the mile (land mile and nautical mile) for the survey system of any country and its outlying coasts. For the mass one has to consider the Cwt. and ton which are multiples of the pound and the Metric ton (1,000 kilogrammes).

The next derived unit of importance is that of volume. The British Unit, gallon, is a liquid measure and legalised to be the volume of 10lbs. of water. For the measurement of seed grains the British unit happens to be "Bushel". In considering the volume measure of agricultural produce of our country one is confronted with the difficulty, viz., in each province and even in the districts of these provinces different cubic measures are in vogue. A reference to the District Gazettes published by the Government of India will indicate how different and how complex this cubic measure happens to be. (Bombay Province has enacted a system of standard weights and measures).

The introduction of public utility systems, e.g., the Municipal Corporations, Electric Power Supply Systems, Gas Supply Systems, have brought into existence a number of derived units which require standardisation. The growth of medical science on the western lines have also necessitated the calibration and standardisation of various equipments.

The growth of the different industries, viz., the mechanical, electrical, chemical, textile, building, including sanitation and sanitary equipments, necessitate a considerable amount of standardisation.

Thus the derived standards that are of fundamental importance in the mechanical industries are as follows:—

(1) Tapes, Chain links.
(2) Gauges of different denominations.
(3) Micrometers of different denominations.

For mass determination:—

(1) Balance and Weights.
(2) Volume as derived from mass (Hydrometers and other liquid meters).

For time determination: (1) Ratings of clocks and watches and chronometers.

For force and pressure determination:—

(1) Dynamometers.
(2) Barometers.
(3) Manometers.

(4) Vacuum-meters.
(5) Lubrication and Viscosity meters.

Under this head one would find:—

(1) Energy-meters (other than electrical).
(2) Flow-meters of different types, Taxi-meters for distance measurements.

For instruments concerning the measurement of heat and temperature:—

(1) Thermometers.
(2) Pyrometers.
(3) Calorimeters.
(4) Flash-point Apparatus.
(5) Conductivity Apparatus.

For electrical measurements:—

(1) Electrical measuring instruments of different types.
(2) Resistance standards.
(3) Voltage standards.
(4) Current standards.
(5) Magnetic standards.
(6) Induction standards.
(7) Capacity standards.
(8) Ratings of battery, primary and secondary.
(9) Radio frequency standards (valve ratings and other characteristics).
(10) Generator ratings.
(11) Transformer ratings.
(12) Motor-ratings.
(13) Switch-gear ratings.
(14) Cable ratings.
(15) Telephone Transmitting Equipment ratings.
(16) Photometric standards including lamps and illumination etc., etc.

For optical instruments and measurements:—

(1) Camera lenses.
(2) Microscopes.
(3) Telescopes.
(4) Range-finders.
(5) Periscopes.
(6) Opthalmic Optical apparatus.
(7) Projection apparatus.
(8) Refractory apparatus.
(9) Standardisation of optical glass.

For sound measurements and equipments:—

(1) Musical instruments.
(2) Phonograph and Gramophone.
(3) Loud-speakers of different types.
(4) Microphones.
(5) For measuring the acoustic properties of different materials.

For Surveying different types of levels and theodolites and different instruments for Cartography.

Navigational instruments and equipments.
Aeronautical instruments and equipments.
Metallurgical instruments and equipments.
Radiological equipments and instruments.

Besides the above-mentioned items naturally a number of allied problems arise in connection with these standards which require constant attention and thorough examination for the national development of any country.

Thus the different western countries felt the need of standardisation to secure a uniformity in the distribution of social amenities of life as well as fostering the growth of industries, trade and commerce. Different nations have established National Standardising Laboratories. Thus the oldest laboratory is that of Germany, viz., Physikalische Technische Reichsanstalt at Berlin, the French Institution is the Conservatoire des Arts et Metiers, at Paris, the British Institution is the National Physical Laboratory of Teddington and the National Bureau of Standards, Washington D. C. of America. The United States of Soviet Russia have established a Standardising Laboratory. Other nations have also similar standardising laboratories.

The National Bureau of Standards, America, is a government department incorporating a number of Standards Committees, e.g., the American Marine Standards Committee, Committee of Electrical Standards, Committee of Commercial Standards, Committee of Standards for Health and Sanitation, Committee of Standards for Engineering Standards, Committee of Illumination Standards, and a number of other standardising bodies.

III. STANDARDISING INSTITUTIONS

Besides these laboratories there are Standardising Institutions in the different countries, representing various Government Departments, Industrial concerns and Technical Associations. In England the British Standards Institution is an example.

(i) Its main function is to issue the British Standard Specification. Its main object is that such nationally accepted specifications safeguard purchasers by ensuring a generally suitable quality and performance at a reasonable price.

(ii) It is an independent body in the closest touch with industrial requirements and modern technical knowledge with the fullest government support but free from government control.

(iii) It is in direct touch with the standardising bodies in foreign countries and participates directly or indirectly in the work of International Standardisation as and when industry so desires.

(iv) The affairs of the Institution are governed by a Council in which industries are fully represented and on which are also represented the Board of Trade, the Department of Scientific and Industrial Research, the National Physical Laboratory, the Federation of British Industries and the Association of British Chambers of Commerce. It has four divisions, viz., (a) Engineering; (b) Chemical; (c) Building and (d) Textile.

(v) The funds of the Institution are principally derived from industry, though H. M. Government together with the Governments of the Dominions overseas and India, Crown agents for the colonies, Municipal Corporations and Technical Institutions contribute liberally.

It has already issued more than 500 standard specifications for the industries and the several Government Departments. A new section, viz., that of Air-Craft materials in co-operation with the Air Ministry have also issued more than 200 specifications.

The German Standards Association is the Institution or Association of German Engineers (VDE) and it consists of a general Council representing various Technical Committees, Industrial Associations and Government Departments. It also issues standard specifications for the different German articles used in different trades and industries and such a standardisation has helped considerably in the rapid growth of German industries.

The French, the Swiss, the Belgian, the Dutch and the Swedish Governments have also similar Institutions and owing to the close co-opertion of these different International Institutions, the industries of different lands have come to a better uniformity regarding their products.

It is noteworthy to mention that quite recently the Australian Government have decided to set up a Standard-

ising Laboratory in Sydney with the close co-operation of the University of Sydney, to foster the growth of industries.

The present condition of Indian industries is such that it is entirely governed by the specifications of the British Standards Association and it is expected that the conditions laid down in these specifications are in conformity with the practices that prevail outside India. No enquiry so far known has been done with reference to the conditions pertaining to the actual needs of the Indian conditions for the local Industrial concerns. The healthy and natural growth of Indian industries would, therefore, require similar organisation with due considerations of the material available in the country as well as to satisfy the actual needs of the people of the country.

These are the broad lines on which one should consider this very important question for the considerations of the National Planning Committee.

IV. GENERAL CONSIDERATION FOR THE SUB-COMMITTEE

From the above consideration it is easy to realise the necessity of a Standardising Council and Standardising Institutions under the system of National Planning and the following points have got to be decided in this connection:

(1) The need for a Central Council of Standardisation for the whole of India.

Personnel of the Council:—

(i) Representatives of the various Provinces.
(ii) Indian States.
(iii) Industrial Concerns, Boards of Trade.
(iv) Different Government bodies, (e.g., Surveyor General, the authorities of the Mints, different Observatories in India, Departments of Communication, Engineering, Railways, Posts & Telegraphs, Naval Authorities, etc.)
(v) Different Universities, and independent Research Institutions.
(vi) Different Provincial Departments of Industries.

(2) The desirability of the establishment of Standardising Laboratories in the different provinces of India, and Indian States.

(3) The desirability of the establishment of a Central Standardising Institute. The location of this Institute should, as far as possible, be decided upon from the point

of view of ensuring close contact between industrial concerns and the Institute.

(4) The desirability of the All India Standardising Council having relationship with International Standardisation Commission.

since one has to consider the derived standards which are of prime importance in the social structure of the nation, in their daily avocations of life and also such standards as are required in the various Power producing industries, Metallurgical industries, Mining industries, Mechanical industries, Industries for the maintenance of Transport and Communication and Industries relating to the production of Equipments for the Defence of the country.

The standardisation Laboratory should have different sections under which different types of standardisation have to be conducted and maintained. Thus the following sections are suggested:—

Department of

(1) Physics having the following sections:—
  (a) Temperature standards.
  (b) Acoustics standards.
  (c) Optical standards.

(2) Electricity with the following sections:—
  (a) Electrical standards and measurements.
  Electro-techniques.
  (c) Photometry.

(3) Communication having the following sections:—
  (a) Telegraphy.
  (b) Telephony.
  (c) Radio and Wireless.
  (d) Block-signalling for Railways.
  (e) Rly. transport and other mechanical transports.

(4) Metrology with the following sections:—
  (a) Line standards.
  (b) Mass standards.
  (c) Volume standards.
  (d) Pressure standards.
  (e) Gravity standards.
  (f) Surveying equipments standards.
  (g) Time measurement standards.
  (h) Meters (other than electrical).

(5) Engineering having the following sections:—
  (a) Materials of construction.
  (b) Lubrication.

(c) Road research.
(d) Strength and design of structures including buildings.

(6) Metallurgy with the following sections:
(a) Refractory material standards.
(b) Alloys.
(c) Fuel and furnace.

(7) Aerodynamics with the following sections:—
(a) Aircraft performances.
(b) Wind Tunnels.

(8) Chemicals and Drugs with the following sections:—
(a) Standard chemicals.
(b) Assaying of drugs and chemical and pharmaceutical products.
(c) Chemical Engineering.
(d) Explosives (especially relating to such as are to be used in mining operations).

(9) Navigation having the following sections:—
(a) Stability of navigable structures.
(b) Experimental tanks.
(c) Performances of models and actual crafts.
(d) Materials of construction suitable for navigation purposes.

(10) Special Investigation:—
This department will undertake to standardise all materials and equipments necessary for the advancement of the country which do not come within the purview of other departments.

(11) Department dealing with the Standards required in the Manufacture of Arms and Munitions for the defence of the country.

It may be mentioned here that the provincial standardising laboratories may not have all the departments indicated in the above mentioned list but there are some essential departments which every province should possess. They are of such a nature as would be of paramount importance for satisfying public needs and also for such industries as are suitable for the province. The central Institute, however, should be on a more extended plan capable of expansion and addition from time to time as the need for such departments may arise.

CHAPTER VIII

LOCATION AND ORDER OF PREFERENCE IN THE SELECTION OF INDUSTRIES CONNECTED WITH THE MANUFACTURE OF SCIENTIFIC INSTRUMENTS:

Names of the well-known manufacturers of scientific instruments in India and the different types of instruments made by them are mentioned already in Chapter III. Most of these concerns are yet in a state of infancy, except those that are under Government control like the Mathematical Instruments Office and the Workshops of the Meteorological Department. A large number of the manufacturers also do, to a great extent, importing business, and in this manner they are able to find the necessary capital and the necessary contact with the different buyers in the country.

All of them were requested to supply information on the following points:

i. the kind and amount of raw materials from Indian and foreign sources ;
ii. the capital necessary for the successful prosecution of the Industry;
iii. the extent to which skilled labour was already available and the provisions that would have to be made in future for training labour in the crafts which are necessary for the building up of scientific instruments;
iv. the present and future needs of the country in respect of particular types of instruments;
v. the extent of available marketing facilities.

Very few replies were received in this connection and whatever information was collected in this manner was, unfortunately, discovered to be very scanty, disconnected and very much ambiguous. A further attempt was made to compile accurate and reliable information in connection with each and every important instrument that is already manufactured or for the manufacture of which all arrangements are made. The two notes given below are specimens.

Note A gives specific and detailed account of the industry connected with the manufacture of Balances and Scales.

Note B gives the necessary information in connection with the manufacture of D.C. electrical measuring instruments.

NOTE A

A NOTE ON THE MANUFACTURE OF BALANCES & SCALES IN INDIA.

(Note submitted by Prof. G. R. Paranjpe, Royal Institute of Science, Bombay).

Mass is one of the three fundamental units, viz., length, mass and time; and, as such, instruments to measure mass are as old as civilization. Balances and Scales happen to be the simplest and the most universally employed forms of these instruments.

In India ordinary weighing was carried out by means of simple beam balances, having pans suspended from its extremities. The beam, until recently, was constructed out of a uniform piece of wood or in special cases out of a rigid metallic bar. For heavy objects and when the weighing is rough, this simple type works satisfactorily. Most of the marketable commodities like milk, oils, and grain, until recently were uniformly measured by volume only. Cotton was probably the only important article that was weighed and for this purpose appliances capable of handling hundreds of seers at a time were required and there was no need of great accuracy. Precious metals and jewellery were obviously weighed and for this purpose goldsmiths and jewellers needed precise and reliable weighing devices. This was presumably the only important market for scales and balances in India. Major portion of India's requirements in this direction came from abroad, but it is known that about sixty years ago the manufacture of these articles was undertaken by individuals in Cutch, Bhuj and Dharwar. The industry remained mostly in the hands of individual artisans, who devoted themselves only to the manufacture of the so called Swan-necked or goldsmith's scales. The instruments prepared by local artisans were usually good and sufficient to meet the moderate demand in quality and quantity; but they failed gradually to keep pace with modern ideas of accuracy and sensitivity. The class of workers in this field, therefore, began to be behind the times. Their products were successfully replaced by those of foreign make which were cheap and serviceable. When the Weights and Measures Act came to be introduc-

ed, standards of accuracy came to be defined and the local talent and local manufacture found the task beyond their level and they almost disappeared from the field.

Indian Manufacture:

Sir P. C. Ray and others interested themselves in this subject from utilitarian and national points of view. They turned their attention to the organisation of industry for the manufacture of scales and balances.

(1) P. C. Ghose & Co. of Barnagore (Bengal) is known to be the pioneer manufacturer of Goldsmith's scales almost since 1920.

(2) The Balance Works, Benares (1917).

(3) Model Industries, Dayalbagh, Agra (1920).

(4) Bharat Weighing Machines, Howrah.

(5) Balance Works, Surat.

(6) Scales Manufacturing & Adjusting Works, Bombay (1920).

(7) M. Ramchandra & Sons, Bombay.

(8) Bengal Pharmaceutical & Chemical Works, Calcutta.

These are some of the concerns known to be manufacturing beam scales of different types and it is possible that there are others who do manufacture scales, but are not widely known. For obvious reasons the production of the above mentioned works is very much limited both as regards quantity and as regards variety, but the quality of the products is as good as can be expected under the circumstances.

Types of Balances & Scales

The types of weighing machines that are required are numerous, but the following represent the types generally employed:—

(1) Goldsmiths' Swan-neck scales

These are beam type and can weigh from 1 grain to 50 tolas, sometimes as much as 500 tolas. These are now manufactured locally, although the extent of production is very small. Cost of such articles varies from Rs. 1½ to Rs. 5, sometimes Rs. 50/-. These are used by goldsmiths, jewellers, and others, who deal in valuable articles. Indian Medical men, practising Ayurvedic system, use them to weigh out medicinal herbs and preparations.

(2) Grocers' Scales

These are also of the beam type and can weigh from 1 oz. to 40 lbs. These are made locally to a small extent

and cost about Rs. 2 to Rs. 20/-. This type is very common and universally employed by all dealers in grains, vegetables, stores, etc. There is a variation of this, known as Trip Scales, and, though its design is different, the principle is the same. No one appears to be making such Trip scales in India as yet.

(3) Bullion Scales

These are of the beam type and possess great accuracy. They can weigh as much as 500 tolas. Such scales are made locally to a very limited extent, and cost about Rs. 25/- to Rs. 50/-. This type is found useful in Post Offices, banks, treasuries, and with merchants dealing in precious metals.

(4) Weighing Machines & Weigh-bridges

These are of the Danish Steelyard type and can be made to take small as well as large loads. The machines are very compact and sturdy. They do not seem to be made by any manufacturers locally. Their uses are numerous and can be found in smaller forms in shops and in larger forms in Warehouses, Railway Yards, etc.

(5) Spring Balances

These depend upon the elastic property of springs. They are available in all shapes and sizes and capable of weighing anything from a few grains to a few tons. There are also different designs. Platform scales and smaller weigh bridges come under this head. Spring balances are very compact, sturdy and accurate; but their reliability is limited on account of the fact that the elastic property of the spring is liable to vary with load and deteriorate in time. Springs being the major component in this type, these are not yet manufactured in India.

(6) Physical and Chemical Balances

This is, of course, the beam type, but there are different varieties depending on the purpose they have to serve, for instance, there are School balances, Physical balances, Chemical and Analytical balances, Assay balances and so on. The different types are based on different requirements of load, sensitivity, accuracy and reliability. A particular value of precision must result from a particular design and construction. Such balances are made locally and a good many of them have been found quite satisfactory. Balances under this head can cost anything from Rs. 20/- to Rs. 500/-, in special cases even Rs. 1,500/-.

Weights:

Anybody who undertakes to make balances has almost of necessity to manufacture suitable weights and this becomes an art in itself. It is comparatively a simpler job but one requiring extreme carefulness and precision, particularly in the matter of preparing weights of small denominations. With the coming into force of the Weights and Measures Act, the ideas of precision and the necessity of frequent comparison with the standards are beginning to be properly appreciated and the manufacturer of today stands on a different footing than his counterpart about ten years ago.

India's Requirements

It is not possible to ascertain the number of balances and scales of different types in use at present, nor is it possible to estimate how the numbers will grow in the years to come. Inquiries made in this direction indicate that the annual requirement of certain types in the Bombay Province alone are about.

20,000 Scales of the Goldsmith's type,
1,000 Chemical and Physical balances of the accurate type, and
1,000 School balances of the less accurate type.

The number of Grocer's Scales, Weighing Machines and Bridges, platform scales, spring balances used in domestic establishments, in business houses, in railways and in works cannot be estimated. In order to obtain a rough idea to what one single factory in Bombay can at present produce, the following figures were collected. In its total active period of 17 years the factory could produce only about:

500 scales of the Goldsmith's type,
12 chemical and physical balances of the accurate type,
300 School balances of the less accurate type, and
200 Bullion Scales as required by Treasuries etc.

The existing Indian production in this branch can, therefore, be described as not exceeding one tenth of one per cent in value.

Raw Materials

The raw materials for the manufacture of scales and balances are iron, steel, brass, gun metal and special alloys in the form of ingots, rods, pipes, and sheets. The materials are almost all of foreign origin and manufacture and can be available in the Indian market. The industry can

be fully independent when the metallurgical industries will have advanced sufficiently far. The raw materials are now becoming increasingly expensive, although not scarce. Wood is an Indian raw material. Agate is a material employed in the better type of physical and chemical balances, but it can be available locally.

Tools and Machinery

This particular industry does not require any special machinery or tools, but whatever tools are required are exclusively of foreign origin. A unit factory, for preparing Goldsmith's scales, Bullion scales, and chemical and physical balances can be set up with a working capital of Rs. 20,000/- provided all casting and foundry works are done outside. With the opening of a wider market and with the availability of ample raw material and trained labour further units can be added to develop the factory almost indefinitely, until saturation is reached. The most important tool of this industry is individual craftsmanship and accurate and reliable workmanship. There are special tools like automatic punches and dies for mass production, but it appears that in the present circumstances of limited outlook for Indian industries, such mass producing machines are not to be recommended. They are liable to remain idle for a considerable time of the year and cause wastage. There should be enough supply of trained labour, when properly organised; and in point of cheapness and efficiency large mass production tools will not be able to compete for many years. They will eventually come in whenever there is need and demand for them.

Labour

Skilled labour, in the form of metal workers, is already available in large cities, but the same is not directly useful in this specialised industry of scales and balances. It is essential that the workmen receive the necessary training for this particular vocation, owing to its very special features. The most important tool of this industry is, as mentioned already, individual, accurate and reliable workmanship. Given enough capital, raw materials and tools can be purchased; state aid and public sympathy can assure enough market, but correct type of reliable and responsible mechanic is not to be had so easily. The labour must realise the importance of skill, reliability and precision. These qualities must all go together, in case anyone of these is missing, production will be impossible and, if any, it will be worthless.

It is estimated that suitable young boys can take up this vocation and after going through a course of apprenticeship and training for 5 years they can become useful hands, competent to earn as much as Rs. 2 a day. The training should be given, predominantly, in the factory and the course should include drawing, carpentry, metal work, casting, filing, turning, graduating, agate-dressing, electroplating, welding, making of springs, tempering, strength of materials, chemistry of alloys, mathematics and mechanics of the scales and balances, designing and construction, testing, economics of the trade, Indian history and Geography and above all **the art of working without supervision.**

Power

Electrical power appears to be the most suitable for driving the necessary machinery and to provide the necessary illumination. The needs of this industry in respect of other sources of power like coal, oil or gear are not special.

Location

From the point of view of trained labour and market for raw materials as well as finished products, large cities appear to be convenient sites. But there are other considerations viz. high wages, shortage of space, high rents, unsatisfactory sanitary conditions, congested living; and they require that suitable locations for manufacturing centres should be only in the suburbs of big cities.

Capital and Market

These two items happen to be very closely linked with each other as in most other industries, and the experience of the existing manufacturers is very disappointing indeed. Most of them suffer for want of adequate capital. It is observed that a good many of the works, not only making scales and balances but generally all types of scientific instruments, do not command enough liquid finance to guarantee a regular payment of the wages to their staff or to arrange for the necessary and timely purchase of their raw materials. A number of such concerns are dependent on a single individual, who is simultaneously the founder, the capitalist, the brain, the mechanic, the store purchaser and the salesman. It is either misuse of intelligence or dissipation of energy. There is also the tendency of starting rival concerns with the help of so-called experienced technicians on inadequate foundation. The results are split-

ting of finance, loss of trained labour, cutting down prices and little regard for quality. Capital should be made available.

State Aid

Just as in this particular instance the Weights and Measures Act had the necessary beneficial effect as regards the standard and accuracy of weights and the methods of taking weights, so it should be in the whole industry of scales and balances and other allied industries. State protection should be organised, in the form of subsidy, guaranteed market, production and research facilities through Government departments. Standardizing and grading institutions should be established to protect the producer and the consumer. Test Houses should undertake to explore the values of various kinds of raw materials, to examine new plans and new designs and to make recommendations.

Factory Act should be revised in the direction that workmen should be made to feel that their responsibility in the successful working of the manufacture is at least as great as that of the capitalist or of the Works Manager. There should be an organisation which will bring about co-operation (coupled with individual protection) between different allied manufacturers. This organisation will lead to the easy production of such components for which the demand of the individual manufacturer is small and for which collective demand is great and for which special expensive machinery is necessary.

NOTE B

NOTE ON THE MANUFACTURE OF D. C. ELECTRICAL MEASURING INSTRUMENTS

(Submitted by Mr. N. M. Athavale, Laboratory Apparatus Workshop, Poona)

The Dictionary of Applied Physics deals in a brief manner with the main requirements of various types of D. C. Electrical Measuring Instruments. Various Scientific Journals contain articles dealing with the ways and means and precautions necessary for attaining the desired sensitivity. The question dealt with in the note is more of a practical nature and it only attempts to indicate the main problems involved in the manufacture of D. C. Instruments.

The types most popularly used are (1) Switch-board Type, (2) Technical School pattern, (3) Pannel type, and (4) Educative, like classroom ammeters and voltmeters, and galvanometers. Though all these have special characteristics of their own, the main parts common to all are the following:

1. Good quality cobalt steel, permaloy, alnico, or similar magnets;
2. Sapphire bearings;
3. Control springs;
4. Pointers;
5. Coils;
6. Scales;
7. Assembly parts like screws, washers, etc., of various small dimensions.
8. Outside casing.

Each of these require special methods of manufacture and except for a very large concern, all these parts are not manufactured in his shop by the D. C. Instrument maker. The following observations will briefly indicate the way the various parts are obtained.

The magnets can be had of English, American, and Continental manufacturers who manufacture all types of magnets required by the Radio, Telephone and like industries. It will, therefore, be easy and cheaper to buy the magnets of the necessary dimensions from a magnet manu-

facturer. Incidentally, however, it should be noted, that magnet manufacture is a key industry to various manufactures of Scientific Instruments.

What applies to magnets also in a less degree applies to the securing by Jewels and Springs. Switzerland, the centre of many skilled industries, produces jewel bearings required for the electrical instrument maker, watch maker, and balance manufacturer. In India, Cutch is a well known centre for working on agate and other jewels. It will be a valuable research to improve their methods using modern appliances and get these jewel bearings manufactured in India.

Control springs are made of phosphor bronze, silicon-bronze, and cadmium-copper. In the initial stages these springs can be had from abroad, particularly from Swiss and German sources. If, however, the necessary wire, say No. S. W. G. 40 and upward, of the materials mentioned above can be secured from people like Johnson Mather, Ltd. England, experiments in spring manufacture can be started. The greatest and the most costly requirement for this purpose will be the sapphire or Diamond Dies which will convert the wire into rectangular strip of very exact breadth and thickness.

The pointers used are made from aluminium alloys and in most cases they are made of tubes about 0.5 to 1 mm. bore and a wall thickness of 0.01 mm. A German manufacturer who makes all types of fine bore tubes including those required for Hypodermic Syringes, supplies these tubes. They are rather costly, but if ordered in large consignments the cost may be considerably lowered.

It will be plain from the above remarks that magnets, jewel bearings, control springs, and pointers can be manufactured in separate small concerns. Each of these is a nice problem for research in Applied Science for our University Graduates. The other parts of the meters, namely, pole-pieces, coils, various types of screws and nuts, spring and other types of washers are to be manufactured by skilled and experienced artisans who will learn the things as they do them. For a large factory many of these parts are made by small automatic machines and accurate punches and presses, but an equipment of this type is out of the question, unless a fairly large market is assured.

The assembling of the various parts of the meters, calibration and testing also require properly qualified and trained workers. The concern must also possess a fairly good set of standard instruments for checking the per-

formance and accuracy of the manufactured instruments. All this will require not only a considerable outlay of money, but what is of more importance, a set of experienced and skilled scientific men.

As the factory grows, the manufacture of soft iron instruments used for both A. C. and D. C. can gradually be taken up and it will be found to be comparatively easy. In connection with this there is another problem for research, viz., the Cuprous-Oxide Rectifier. If anybody is able to manufacture metal rectifiers, another very interesting line of manufacture, namely that of L.T. and H.T. units so frequently used in radio, can be taken up.

Up till now India does not probably manufacture even a single D. C. or A. C. instrument. The Laboratory Apparatus Works, Poona, are tackling this problem, and have just completed a design for ammeters, voltmeters and Ohmmeters. India's requirements in this direction must be considerable and are likely to grow in future as electric energy will be used more and more in this country. The radio and the motor-car industries will also use a considerable number of these instruments, when they come to be started in India. It is true that for the present 90% of the raw material will be foreign but this particular line of manufacture is not the only one that has got this handicap. It is desirable to make an early beginning, for, it will take at least five or six years to train the proper type of technicians necessary for this work.

These were the only two notes received so far. If reliable information in the form of such notes were available for each and every industry and each and every type of instrument, it would have been possible to make a comparative study of the available facilities as regards raw material, skilled labour, testing, marketing and so on, with a view to make certain recommendations. This was, however, not possible, and it is suggested that every endeavour should be made to procure such information about the existing and future manufacture of scientific instruments.

The following industries appear to be making good progress:—

Laboratory fittings,
School and College laboratory apparatus,
Surgical instruments and appliances,
Balances and scales,
Blown glass ware.

The following should be attended to as early as possible:

Clocks and watches,
Photographic sensitive materials,
Optical glass and grinding,
Telephone and Telegraph,
Calibrated glass ware,
Electric energy meters.

Attention is also invited in this connection to the remarks made in Chapter IV, "Raw Materials", and the necessary investigation that should be undertaken forthwith to supply the industry with adequate raw materials.

CHAPTER IX.

RESPONSIBILITY OF GOVERNMENT IN MATTERS OF CONTROL, FINANCIAL AND TECHNICAL ASSISTANCE, CREATING ADEQUATE TRAINING FACILITIES IN INDIA AND IN FOREIGN COUNTRIES, ENACTING NECESSARY LEGISLATION

(i) Direct State Control

The industry is concerned with the manufacture of scientific instruments required not only in all types of modern mechanised industry, but also in educational institutions carrying on scientific research, engineering establishments, transport and communication services requiring instruments of precision, and hospitals equipped with modern apparatus for curing sickness and maintaining health. It is of such a vital character to the existence of the nation, and to the success of the National Plan of industrialisation, that this industry must be conducted by the State directly as an integral part of the National Plan.

At the present time, as the earlier Chapters have shown, there is no very considerable size of that industry as already developed, though as the figures relating to imports show, there is a very large scope for the development of that industry. And, as the plan of national reconstruction progresses, the scope for this industry will become ever wider.

There are no very great vested interests of private individuals already taking root, which could conceivably offer any serious opposition to the undertaking and carrying on of this industry of manufacturing scientific instruments of all kinds on a large scale by collective enterprise. Such establishments as have already developed under private initiative in this field are themselves very considerably handicapped in regard to the lack of skilled labour, of the necessary and suitable material, as well as the difficulty about patent rights held by foreigners in many instances. They are, therefore, in very considerable and constant need of State assistance in every direction for the very existence, let alone the expansion and development, of the industry under their direction and management. Besides, their activities, such as they are, do not cover

anything more than a fraction of the field required to be covered, if India is to possess, as part of the planned system of national economy, an adequately developed industry for the manufacture of scientific instruments of all kinds.

Given the importance of this industry and its present position in the country, we have premised that its conduct by direct State agency will present no considerable difficulties. If skilled labour and experienced technicians are lacking, the State is the best agency to obtain from foreign sources the necessary technicians. It may make with them special agreements, requiring them not only to help in founding this industry, but also in training up similar technicians from suitably educated Indians, so as to take their place when their contracts expire. If the industry, again, is handicapped for want of the necessary and suitable raw material, e.g., optical glass or magnetic steel, that need also can be met much more advantageously by Government agency than if private individuals were left to operate on their own account for carrying on this industry. All departments of international trade, as between the leading commercial countries of the world, are being nowadays increasingly regulated by special commercial treaties. They lay down not only the amount and quality of the articles to be supplied, but also the terms and conditions on which they have to be supplied. India can afford to remain no exception to this growing tendency of our age. The foreign trade of India, in this particular branch as in others, will come to be regulated more and more by special treaties, even if regulation and control are extended to that field under such treaties as even now operate regarding the foreign trade of India. And, when such trade treaties are negotiated and concluded hereafter, provision will necessarily have to be included in them for the supply of the materials, and even of experts, for helping us to develop this industry.

These facts need but to be stated to prove that the introduction and development of this industry in this country cannot be left, even if it was otherwise suitable to be so left, in private hands exclusively. The problem, however, of locating this industry in its various branches will also cause some complication, which it would be impossible for private individuals to solve satisfactorily. For obvious reasons, the entire industry manufacturing all kinds and varieties of scientific instruments cannot be centralised and located in one place without arousing provin-

cial jealousies. As this industry has grown already, it has done so, in the different parts of the country, without any definite plan regulating its location and growth. If, however, the industry is to work efficiently, it must be planted only in those parts where the necessary facilities of raw materials, skilled and unskilled labour, as well as the market most considerably demanding the products of this industry, are conveniently available.

It may be, of course, that the industry may not be centralised exclusively in one spot; and may have to be developed in different parts of the country in accordance with the facilities and conditions just mentioned. Wherever located and however financed, Government control of a very thorough-going and rigid character would be indispensable, even if, contrary to our recommendation, the industry, or any section of it, is allowed to remain in private hands for any reason that the authorities concerned may deem sufficient for the purpose.

(ii) Regular periodic compilation of various kinds of returns

Whether the industry is owned, directed, and managed by Government directly, through special experts and managing officers appointed for the purpose; or whether it is left in private hands, but subject to very rigid and thorough-going Government control as just mentioned, the Planning Authority will have to make proper estimates, from time to time, and compile very accurate information regarding the annual requirements in respect of such instruments, their quality and quantity, in the several institutions, establishments or factories using these instruments or any of them. Such information Government must obtain and compile from the various institutions,—educational, engineering, medical, communication and transport services, and managers of other industries. Basing their calculations upon this information, the Planning Authority will have to make its own provision for supplying these instruments in the required number, quality and variety, from the indigenous as well as extraneous sources in the best manner that that Authority finds most economical. And for this reason, it will be for that Authority to prescribe the size of operations, the nature of equipment and the volume of output, the industry, however conducted, must put forth.

(iii) Provision of Industrial Research and Study of Applied Physics.

One of the most important pre-requisites for the development of this industry in this country would be, naturally, the more intensive study and provision for scientific research in the Universities and cognate institutions with special reference to Applied Physics. The Universities, or any special body entrusted with this task, will have to institute—with Government help if necessary—special Chairs, and provide special stipends, for carrying on and encouraging the study and research in Applied Physics, as that science is more particularly concerned with this industry. The industrial requirements in respect of the results of such researches will have to be indicated in advance to the Planning Authority. The latter will not only set problems for such research, but also encourage the devising of new instruments, and perfecting or improving the existing ones, so as to be more efficient for the purpose in hand.

The research institutions contemplated in this section will have, therefore, to be in close and constant contact with the industrial organisations of the country, as well as with those other institutions that use scientific instruments. The mistake, therefore, of emphasising in research institutions only the theoretical side as at present will be avoided, and adequate attention paid to the practical side of the business.

(iv) Creation of Special Training Facilities

Side by side with the institution of the requisite number of Chairs and Research Departments, as well as the provision of scholarships and studentships for promoting and encouraging the scientific research in the making, improvement and perfection of scientific instruments, there must be enforced a scheme of training apprentices for carrying on this industry after the foreign experts' contracts come to an end, assuming that such experts would have to be attracted from abroad in the first instance. For the purpose of finding suitable apprentices in regard to this industry, the resources of the various educational institutions in the country, and even of the private industrial concerns, will have to be carefully scrutinised; and only such candidates preferred as, by their training, education as well as aptitude, give a fair promise of success in this case. The training of such apprentices is not merely intended to make of them expert craftsmen in the produc-

tion of such instruments; it is also calculated to fit them to take a broad view of all connected activities in regard to this industry. Their training should, therefore, include some instruction in all connected subjects, like economics.

Where facilities for training apprentices within the country for this purpose are not adequate, Government will have to arrange for a systematic scheme to depute regularly, a number of apprentices for further training in foreign countries where such establishments exist. These students will have to be secured admission in the right kind of establishment, whether educational or industrial, to see that their training is effective, and the money and time devoted for this purpose are not wasted. And, when the training has been completed, including both a theoretical knowledge of the particular subject studied as well as its practical applications, the people so trained will on their return have to be given suitable employment within the country itself.

All these activities, which are indispensable for the growth and development of this industry, can only be carried on by and through the Government of the country. It is impossible for any private individual to attend to it and succeed in carrying out any part of these activities. Government would have to devote considerable funds and energies for this purpose. As these funds are collected by the Government from taxes levied upon the public at large, there seems to be no reason why the benefit of this expenditure should go exclusively to private profit-seeking individuals engaged in the prosecution of this industry. It, therefore, makes a further argument in support of the recommendation already made above, that this industry, as and when established and developed, should be under direct public ownership, management and control.

(v) Central National Standards Bureau and Test Houses

The counterpart of this industry involves the institution of a Central National Standards Bureau, and a number of Test Houses scattered throughout the country in appropriate places and with adequate facilities in regard to laboratory, personnel, library and commercial intelligence, that bear upon the task of testing and certifying such instruments. More than one sub-committee of the N.P.C., we understand, have already recommended the institution of a Standards Bureau. We need, not, therefore, dwell any longer on this subject beyond endorsing the recommendation already made. The Bureau of Standards

would have a special significance in regard to this industry which hardly requires to be emphasised further. At the present time the variety of weights and measures all over the country, and in one and the same Province very often, creates such a confusion, that efficient working of industries by means of instruments of precision is almost impossible. If this handicap is to be removed, it would have to be one of the first tasks of the Planning Authority to see to it that all those standards which are concerned with weighing, measuring, etc., are established, if necessary by national legislation, and enforced throughout the country on a uniform scale.

Government help would also be indispensable for finding out and improving the necessary raw materials, and for carrying on the research required for that purpose. Appropriate designs and economic methods of technique in the production of these instruments, when the necessary raw material has been found, will also require research that can only be financed adequately by public activity.

If Government establishes the industry under their direct management, in the several provinces or regions of the country, where the facilities mentioned above are available in an ample measure, the institutions or firms now producing scientific instruments needed for further development of this industry, will have to make available to the managers of this industry such information and instruments as may be in their possession, so as to help them in developing this industry still further. Universities, Government Offices, and Commercial or industrial establishments in private hands, will, therefore, have to maintain close and constant contact with the industry as it is developing, so that no link may be missing in the successful prosecution of that industry.

(vi) Questions relating to Protection and Patents

On this assumption, it would not be necessary for us to consider any scheme of special protection and encouragement to this industry, which would be needed if it was left in private hands. Whether left in private hands, or conducted as a direct public enterprise, the question of preference to and protection of this industry cannot arise, for the simple reason, that the community as a whole, as represented by its Government, will be vitally concerned in the success of this industry. Every measure will, therefore, be taken by that authority to ensure its success. Whether that measure relates to the compulsory require-

ment from all private institutions using such instruments in their daily work, that they should be bought from indigenous makers in preference to corresponding makes of foreign origin; or whether there is created an absolute monopoly for the production as well as the supply of such instruments, whether of domestic or of foreign origin, it is unnecessary for this sub-committee to examine at any greater length. We would leave it to the proper authority under the Planning Commission to determine the exact modes in which the demand side is to be attended to, so far as the products of this industry are concerned.

There may be, however, other industries in private hands which also require frequent use of these instruments. Government may, however, have to insist, by legislation or executive order, that all those industries in need of the help of scientific instruments will indent for those instruments only with the national factories concerned with the making of such instruments; and if they have to import any particular item from abroad, they must do so only through the central agency established under the Planning Authority for the purpose of carrying on foreign trade in such regard.

(vii) Legislation

Regarding legislation in connection with the manufacture and use of scientific instruments, the sub-committee have already recommended, in the previous chapter, the necessity of instituting a National Standards Bureau, and also uniformatising the weights and measures used throughout the country. Central legislation will have to be passed for the purpose, and administrative machinery set up in all the units of the country to ensure proper observance of these standards.

For the efficient development of these standards and their maintenance, or testing of the scientific instruments, a Central Standardising Laboratory would also have to be established by Government to determine the accuracy, efficiency, and quality or grade of the instruments produced in the establishments under Government control or ownership and offered for sale. Wherever any Government Department has occasion to use such instruments, or when semi-governmental bodies and statutory authorities like Municipal Corporations, Universities, Port Trusts, etc., and other educational institutions have to use in their every day work scientific instruments, they must be required, by executive order or legislation as the

case may be, to refrain from buying foreign articles in every case where corresponding articles, locally made and certified to be of approved quality by the Central Government Test House, are available. Their quality and efficiency will of course have to be guaranteed and certified by Government, so that the use may be made, on as wide a scale as possible, of these articles.

It may be necessary to introduce legislation, also, in order to secure adequate protection for the manufacture of these instruments, and of any special devices involved therein. Patent right is a recognised property right protected by international agreements; and local legislation is enacted in every country in support and maintenance of this right. The Government control over the production and supply of such instruments is dictated, with a view not only to safeguard the interests of the user of such instruments—so that he could get the maximum value for his money—but to protect the producer so that he may be free from the anxiety of constant competition from more advanced manufacturers. This competition will be inevitable for years to come as regards the makers of scientific instruments in this country if they are private individuals however protected. This latter, however, would be of progressively diminishing importance in proportion as the control of the industry, its direction, management and ownership are taken over by the Government and exercised in public interest. But, for the sake of the industry itself, the agency producing these instruments will have to see that the quality as well as the efficiency of these instruments is up to the minimum specified standard, in any case.

The question of patent right will have to be considered by the Planning Authority very carefully before the necessary legislation is drafted. It will apply not only to the patents acquired by agreement from foreign countries by Government or private individuals, but also to new patents that may be devised by the workers in public laboratories, Test Houses, and in institutions conducting scientific research. Patents may also be taken out by private industrialists, or their staff, in regard to the instruments, processes and machines which help to improve the yield or the quality of the produce in any given industry. The violation of patents, particularly in foreign countries, is nowadays a common phenomenon, which will also require to be adequately protected by local legislation, in conformity with such treaty obligations as may have been

incurred in that behalf. Legislation, therefore, relating to patents, even if formulated, will have to be scrutinised carefully not only by the Planning Authority, but also such bodies of public opinion as are organised within the plan and are concerned with private enterprise mainly in industries not directly conducted by Government.

DRAFT RESOLUTIONS:

The following resolutions in connection with the Report of the Sub-Committee on "Industries Connected with the Manufacture of Scientific Instruments", are recommended to be adopted by the National Planning Committee.

1. In order that Planning may be accurate and effective, a census of all forms of production of scientific instruments, in small and large factories, as well as in non-commercial institutions managed by Government or private associations, is necessary. Legislation for this purpose should be undertaken. The subject of Applied Physics, which is generally neglected, should be given a prominent place in all University Centres and it should be studied from both the theoretical and practical points of view.
2. The industry connected with the manufacture of Scientific Instruments should be conducted by the State on account of its national importance, but, as a matter of expediency, some manufactures may be left in private hands.
3. Those industries that are allowed to manufacture Scientific Instruments as private concerns should form themselves into an Association with the following objects:
   i. To secure raw materials and components on a co-operative basis from Indian as well as from foreign sources;
   ii. To secure production facilities, which depend on the use of specialised and expensive precision machine tools;
   iii. To adjust proper division of work among the different manufacturers in the country with a view to avoid wasteful overlapping and unnecessary competition;
   iv. To ensure detailed examination of the scientific principles and mechanical artifices employed in the manufacture of diverse instruments;
   v. To secure adequate facilities from the Provincial and Central Standardizing Institutions and Test Houses;

vi. To secure adequate State support in matters of capital, expert technical advice, protective legislation and marketing facilities.

4. It is recommended that the Director of Industries in each Province should endeavour to collect detailed and accurate data, as far as possible, as regards the annual requirements in the matter of scientific instruments, their quality and quantity, in the educational institutions, Universities, Research Departments, Medical Institutions, Communication and Transport Services, large and small manufacturing industries of all kinds in the Province.
5. A scheme for the supply of skilled labour, in the form of arrangements for training apprentices in different industries should be worked out and introduced, without any delay, by each Provincial Government in close co-operation with the different manufacturers in that Province. The training should be on a wide foundation, so that the workman will not be denied that status in society which his education and skill will entitle him to attain.
6. It is recommended that Government should make the necessary arrangements whereby it would be possible to send large numbers of properly equipped apprentices to foreign countries and secure for them adequate training facilities and actual experience in the technique of the production of scientific instruments of all sorts and in all stages.
7. A Standards Institution should be established at an early date. This Institution should prepare and issue standard specifications for various instruments that are manufactured or imported and used in India. Such standard specifications will, on the one hand, safeguard the purchaser by ensuring a suitable quality and performance at a reasonable price, and on the other hand, safeguard the manufacturer by minimizing unfair competition. This Institution should work in close collaboration with the Central Standardizing Bodies in the various parts of the world.
8. Scientific research is necessary for evolving suitable raw materials, for considering suitable improvements in designs, for recommending new methods of production of either components or complete

instruments. There should be a State Department of Industrial Research, which should establish a separate Scientific Instruments Committee. This should be well equipped and constantly maintained with ample up-to-date facilities in regard to Laboratory, Library, Personnel and Commercial Intelligence. It would be the business of this Committee to initiate and undertake investigations in all matters pertaining to the manufacture of scientific instruments, from the selection of raw materials to the production, testing and marketing of the ware.

9. At each provincial centre, there should be a central museum, where a collection of scientific instruments of different foreign manufactures should be kept. This will help study and detailed comparison. There should also be in the museum a complete set of special precision tools for study and use, if necessary. The museum should also contain a good library of instrument manufacture and standard specifications and tests prescribed by the Standards Institution. It is recommended that the proposed museum, or some other suitable organization like the Indian Science Congress, should organise periodic classified exhibitions on the latest types of scientific instruments and devices at important Provincial centres.
10. The Board of Scientific and Industrial Research should interest itself in the production of the following items which are of the utmost importance to the industry of scientific instruments:
    1. Optical glass;
    2. Special alloys for tools, springs, magnets, resistant materials;
    3. Synthetic resins and ebonite;
    4. Tubes of brass and other metals;
    5. Abrasives and grinding materials.
11. It would be considerable encouragement to the industry if all Government and semi-government departments agree to purchase their requirements of scientific instruments and appliances from Indian concerns, provided, of course, they have adequately received the approval of the Test Houses and Standardizing Institutions. Government could also sponsor certain industries which would eventually make India self-sufficient in matters of defence.

12. It is recommended that legislation should provide for inadequate protection and preference. In the transition period, imports of components and raw materials should be gradually discouraged or altogether stopped wherever possible. An assembly of parts, which builds up an instrument out of components, particularly imported, should have the second preference.